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OVERHEAD ELECTRIC LIGHT WIRES.

THE regulations recently issued by the Board of Trade with reference to the erection of overhead electric light wires, though in the main satisfactory, are in some respects open to criticism, and in one or two important cases they bear evidence of having been drawn up by unpractical and unskilled hands. Taking the regulations in order, Nos. 1, 2, 3 and 4 do not call for remark. No. 5, which states that "every aerial conductor shall be protected by efficient lightning protectors of pattern approved by the Board of Trade," seems an unnecessary elaboration, as it is difficult to imagine that the most grossly ignorant could fail to know how to fix a simple earth wire to a support. With regard to No. 8, experiments on the radiating effects of different insulating materials are badly wanted, for at present practically but little is known on the subject ; in this regulation it is stated that "special care shall be taken that the cross sectional area and conductivity at joints is sufficient to avoid local heating, and that joints are protected against corrosion." In reference to the latter it may not be generally known that where the use of spirits of salts is objectionable Venice turpentine forms an excellent flux, and is far better than rosin. Regulation No. 9 states that "every high pressure aerial conductor must be continually insulated with a durable and efficient material, to be approved by the Board of Trade, to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation must not be less in inches, or parts of an inch, than the number obtained by dividing the number expressing the volts by 20,000." The thickness mentioned we consider to be ridiculously inadequate for the purpose, the very idea of a one-tenth inch insulation, if suggested for telegraphic purposes to a telegraph engineer of any standing, would be simply laughed at, and to employ it for a potential of 2,000 volts is preposterous. We are perfectly aware that one-tenth of an inch would completely resist a potential of over 2,000 volts if it could be maintained absolutely perfect, but such a thing practice has over and over again proved to be impossible, and no amount of outside protection would prove effectual, especially when we consider that an aerial cable is not supported all along its length, but at a series of points liable to abrasion. The condition stipulated in regulation No. 10, viz., that the insulating material must not be liable to injurious change of physical condition when exposed to any temperature between the limits of 10° F. and 150° F., renders the use of gutta-percha out of the question, but Henley's ozokerited rubber core is one of the few substances that would stand such a test. In No. 11, where the insulation of the lines is dealt with, it is not mentioned that a test taken in dry, hot weather, would be perfectly useless. The requirement in No. 12 that every high pressure conductor shall be efficiently suspended by means of non-metallic ligaments to suspending wires is decidedly absurd, as in wet weather such ligaments would become conducting, and would be useless for any purpose of insulation ; moreover, they would be liable to decay, and could not therefore be depended on mechanically, especially where the conductors cross roadways, and where, consequently, they could not be examined. Regulation 13, which requires that for alternating currents "the two conductors shall be run parallel with each other, and at a distance apart not exceeding 18 inches," is no doubt framed with reference to the effects of the currents on telephone circuits ; it should, we think, be supplemented by a minimum distance of the conductors from telephonic wires being required ; this, however, is partly provided for by regulation 17. Regulation 18, which requires that a plan of the arrangement of the proposed wires shall be handed to the Postmaster-General, and the latter shall, if necessary, require certain alterations to be made, is quite as it should be, though the telephone companies, who are most interested in the matter, do not appear to be considered. Taking the regulations as a whole, they may be considered as fairly satisfactory, though in some respects they will require to be modified. We observe that in the opening clauses it is stated that "A difference of potential on the alternating current system shall be deemed to be the equivalent of a difference of potential on the continuous current system, when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament." This clause would almost seem specially drawn up for the benefit of Major Cardew, as it will involve the large use of his excellent voltmeter.

AT the half-yearly meeting of the York Tramways Company, held last week, one of the shareholders asked, in view of the high cost of horse-power, whether the York roads were not suitable for the application of electricity for power purposes, and whether that power would be equally economical and safe. The chairman, Mr. J. Kincaid, of Westminster, stated that electricity was equally safe, and that the York Company had powers to work by mechanical power. In a small undertaking of that kind there would be a great risk in the introduction of mechanical power, and the directors did not care to take any steps in the matter until the improvements in electricity were more advanced. They would, however, consider the subject, and when matters were more satisfactory the use of mechanical power would again be brought before the shareholders. It will, of course, not be advisable for us to refer the York Company to the tramcars running in Brussels, and about which we have several times written editorially; but we would draw the attention of that company to, among others, the electric tramcars which will shortly be started in Birmingham, and with which excellent results are anticipated.

UNTIL about a fortnight ago the Langley Mill Gas and Coke Company supplied gas at the rate of 4s. 5d. per thousand cubic feet of 16 C.P. gas, but upon the Tradesmen's Gas Association, of Heanor, representing that that price was too high, the company reduced their rate to 3s. 11d. Now, if the company were to take up the supply of electricity they could sell it at the same price as gas, namely, at about 4½d. per Board of Trade unit, although this would not leave a large margin of profit. Still, it *could* be done, and then, again, electricity for power purposes would be extremely useful in that district.

THE Birmingham Compressed Air Power Company held their half-yearly meeting in that town last Friday. Mr. H. Wright, the chairman, stated that the business of the company was gradually extending. In Paris, he said—referring, we presume, to the Popp Company—dynamos supplying about 8,000 glow lamps with current were driven by air power, and he had no doubt that a similar development would take place in this country. This, in our opinion, might be true, provided there were no central electric light stations, but as this branch is making such rapid strides it is extremely improbable that the chairman's anticipation will ever be realised.

SOME few months ago the Lothammer Gas Company was floated. The "Lothammer gas," it will be remembered, consists of ordinary coal gas pressed through a spirit, the one generally employed being gasoline. This increases the illuminating power of the gas. At the time of the issue of the prospectus, that eccentric paper, the *Weekly Bulletin*, with its more eccentric editor, made the extraordinary statement that the "Lothammer gas would revolutionise the art of lighting, and entirely supersede electricity." This absurd theory has not and never will be realised in practice. At the statutory general meeting of the company, held on Friday last, it was stated that the company had made some progress, but from the general tone of the meeting it appears that the shareholders were not *entirely* satisfied with the results hitherto obtained, although such splendid returns were held out at the time of the issue of the prospectus.

IN anticipation of the meeting of the British Association at Newcastle-on-Tyne next month, a series of handbooks has been issued. That entitled, "Handbook to the Industries of Newcastle and District," edited by Mr. Digham Richardson, is exceedingly interesting, and it contains several well executed coloured maps and diagrams. The book deals with the Northern coal, iron, steel, and allied trades, and contains a paper by the Hon. C. A. Parsons on "Electricity." The author mentions that associated with Newcastle is the historical invention of Mr. (now Lord) Armstrong's hydro-electric machine, whereby the energy of high-pressure steam escaping from jets is partially converted by friction into that of a charge of high-tension electricity. This machine, it is claimed, was the first apparatus constructed for the direct conversion of steam power into electrical energy, although the quantity produced was very small as compared with that developed by the modern dynamos. One of these machines was presented to the Durham College of Science by the late Mr. Henry Watson, and is exhibited in the Museum. Referring to transformers, we find that they were first brought before the public at the Newcastle Exhibition in 1887. The turbo-electric generator is mentioned, as are also the two local electrical firms. In the chemical portion of the book some excellent information is given concerning the manufacture of sulphuric acid. Those electrical engineers who intend to be present at the British Association meeting will find this handbook extremely useful and interesting.

A FEW weeks ago we commented upon a little squabble between Dr. George Herschell and the Institute of Medical Electricity. It now appears that the gentleman who publicly stated that the Institute had descended to the level of advertising electropathic quacks is described in the 1889 *Medical Directory* as Physician to the West End Hospital for Epilepsy and Paralysis, to which is attached a *School of Massage and Electricity*. At least this is what we gather from the reprint of a letter addressed by Mr. Wm. Lant Carpenter, B.A., B.Sc., to the *Hospital Gazette*. Further comment on this unseemly attack upon a rival scheme is therefore rendered unnecessary, and we will therefore leave Dr. Herschell to the tender mercies of the Chairman of the Board of Directors of the Institute of Medical Electricity from whom he will evidently get but scant courtesy.

WE had hoped that Mr. Bracken's paper on "Electric Traction with Secondary Batteries, which we publish elsewhere, might have shown that the report from Brussels, upon which we commented last week, was either very much exaggerated or based upon false premises. It is disappointing to find that he cannot place before his readers anything more definite, In the circular sent out by the Secretary of the Institution of Electrical Engineers for members or associates to return as a voting paper for or against the present system of electing council, there are spaces left for address, signature, nomination, and vote. A well-known engineer filled up his paper, placed upon it a halfpenny stamp as directed, and returned it to the offices of the Institution. Eventually it came back to him as having been refused, and on it was the Official Post Office stamp, "In the nature of a letter." Now this, from the postal authorities point of view, can only mean that the worthy secretary had not conformed to regulations in compiling the missive, and that it in consequence bore insufficient postage; but, even then, we cannot understand why the secretary or his clerk should refuse to take in a voting paper directed by themselves to themselves, and which had been prepared entirely in accordance with printed instructions. An explanation is certainly necessary, and it would be interesting to know how many other voters can relate the same experience.

Various schemes, other than by steam power, have recently been brought before pleasure seekers for the propulsion of launches on rivers and lakes. *Apropos* of this, we learn from our trans-Atlantic namesake that a terrible accident occurred at Buffalo recently, when an exploding naphtha engine killed and wounded several of a pleasure party about to embark for an afternoon trip. While electricity and electrical power, says our contemporary, are being so thoroughly appreciated as to have no need of profiting by the shortcomings of other power agencies, still, in view of the general clamour in the daily Press as to the dangers of electricity when anyone carelessly and heedlessly touches a wire which he has no business to touch, and thereby is shocked more or less seriously, it is not out of place to call attention to this danger which threatens the users of naphtha engines. The comparison between this deadly machine and the electric motor fed by storage batteries and perfectly applicable to the same use, speaks for itself. Our namesake, however, may not be aware that in this case the naphtha was used as fuel, and not in the spirit form as adopted in launches built in England.

We are periodically asked whether we can enlighten our interrogators upon the motor competition which was instituted some time since by our esteemed contemporary, *Industries*. We really do not know the ultimate decision in this matter; but, whatever it was, it seems to have given rise to much dissatisfaction. We understood that both the Editor, and the company owning the journal, disclaim any responsibility, and there the subject ended; but we do not give this authoritatively.

Now that the cables connecting this country with the Continent of Europe are controlled by the Post Office, it has been found necessary to issue new regulations governing the despatch of foreign telegrams. These regulations are very voluminous, and they cover every possible form in which a telegram could be devised by the most ingenious person. The minimum charge for a message is fixed at 10d., and ten letters are specified as the maximum length of a word. Registered telegraphic addresses are permitted, and a foreign telegram may be sent to the semaphore station for the purpose of being telegraphed to a ship. The Post Office authorities have also introduced the system of multiple addresses in the same town. The regulations may be found in the official *Gazette*.

It is very difficult to get at correct figures respecting the mileage of American electric tramways. *Scribner's Monthly* states that there are 400 miles in operation, and much more under construction; but other authorities in the States give different results. *Scribner*, however, is about right, if we may judge from Mr. Mansfield's paper, which we publish on p. 245.

A few weeks ago press notices were sent out inviting ourselves and others to inspect the Barking-Canning Town electric tram line. Some days before the appointed meeting another letter was circulated cancelling the engagement. As we have been asked by several friends certain questions concerning this tramway, we should be pleased to know when it will be convenient for the directors to submit the line and cars to inspection. Surely the explosion of gas from the accumulators, to which we drew recently attention, was not of such a serious nature as to render further delay necessary?

A patent which relates to a simple arrangement of mechanism for regulating the current of dynamo machines might be thought to contain but few claims, yet Mr. Sperry's specification for obtaining the above result is drawn out to the inordinate length of thirty-one. We believe that the famous Edison telephonic patent originally consisted of a number but one less, but in amendments there was left but a solitary claim.

Our old friend Theophilus Coad has been immortalised in a weekly contemporary which makes a speciality of inventions. We read in its last issue that "For some years past it has been the endeavour of electricians to invent a cheap, reliable, and inodorous primary battery, one that could be with safety used and easily manipulated, so that it could be managed by the uninitiated in electricity without fear of damage to the lamp or to themselves. Several endeavours have been made by different inventors in this direction, but it has been left to Mr. T. Coad, of Soho Square, to introduce a primary battery containing the necessary requirements to make it applicable to domestic and the various other purposes to which the application of the electric light would be an undoubted boon." To our knowledge Mr. Coad has solved the problem of domestic electric lighting so many times, that we wonder he has now any solution left even to fill those famous batteries of his which consumed no zinc, although this precious metal formed one of his plates.

We have perused with interest two letters which appear in last week's issue of *Engineering*, upon the recent explosion of a main steam pipe at Deptford. The first, from a "Foreman Coppersmith," deals with the question from a coppersmith's point of view. The writer affirms that throughout a long experience he has had no failures when carefully watching the work, seeing parts properly put together, and thoroughly testing the work when finished, consigning all ill-constructed pipes to the scrap-box. From personal observation, "A Foreman Coppersmith" has seen many pipes and bends badly made and clumsily put together, and never tested. This being the case it is high time that some official body were authorised to control the testing of all copper and other steam pipes, especially when we take into account the lamentable result before recorded. W. Schönheyder in a letter on the same subject thinks too much blame has been attached to the weakness of the bend in the pipe, and suggests that means be adopted so that no water can accumulate above the valves.

ON CONTACT ELECTROMOTIVE FORCE.

By J. ENRIGHT, B.Sc.

In a Note by M. N. Piltschekoff, which appeared in a recent number of the ELECTRICAL REVIEW, the author opens with a statement for which, it appears to me, the facts at present known to us afford neither proof nor support.

"It is well known that the magnitude of the difference of potential which is produced at the contact of any two bodies whatever is a function of two variable conditions: (1) the chemical nature of the bodies; (2) the physical condition of their superficial strata." I refer to the first assertion.

On examining the tables of contact difference of potential given by Professors Ayrton and Perry, I find that strong $H_2 S O_4$ and zinc in contact give rise to a D.P. of ·848 volts, whereas the same acid in contact with platinum gives a D.P. of 1·3 to 1·6 volts. Now, we know that $H_2 S O_4$ has no chemical effect on platinum, and the fact of the contact of two chemically neutral substances giving rise to such a D.P. as 1·6 volts is not much in favour of the principle set forth as being "well known," and the other fact, that the contact of $H_2 S O_4$ with zinc, which it vigorously attacks, gives a much smaller D.P., is less still in favour of it.

Again, the contact of mercury with iron gives a D.P. of ·5 volts, whereas mercury with platinum gives only a D.P. of ·156 volts, although mercury rapidly attacks platinum and is neutral to iron.

It also appears from the same valuable tables that the D.P. arising from the contact of distilled water with platinum is *greater* than the D.P. of the contact of the same liquid with any of the metals—copper, iron, lead, tin, zinc, all of which, as everybody knows, oxidise more rapidly than platinum. Any correction for the "air effect" applied to the instances cited will not materially alter the case.

Not so, however, with copper and zinc, between which there is no chemical affinity, and yet a D.P. of ·76 volts measured in the ordinary way is supported by their contact. Prof. Lodge explains this by assuming that a D.P. arises from the contact of both copper and zinc with air; and by a calculation based upon the heats of oxidisation of these metals, he fixes their magnitude at ·8 volts from the contact of air and copper, and 1·8 volts from the contact of air and zinc.

This latter is a very large quantity, and, had it a real existence, ought to admit of direct experimental demonstration. It is pretty certain from the experiments of Mr. Brown that the contact of a gas with a metal may give rise to a D.P., but we are now concerned only with this particular combination, and the present writer, who at one time had a strong belief in the 1·8 volts, made many efforts to detect them. Considerations such as the following suggested the experiment described below for the purpose:—The contact (secured by rubbing) of insulated brass with flannel electrifies both. A brass bullet accordingly shot through a bale of flannel would become charged, and share its charge with an insulated brass plate placed in its track. The charge on the plate may then be detected by a quadrant electrometer.

Similarly a number of fragments of bright zinc let fall through air ought to become charged if the contact of air and zinc produced a D.P. of 1·8 volts, and an insulated zinc plate placed in their track ought also to become charged.

Experiment.—A large sheet of zinc was brightened with fine sandpaper. A portion of it was then made into a double funnel, which was fixed to a highly insulated stand. Another portion of the sheet was cut into fragments. A third portion was made into a scoop, which was filled with the fragments. The scoop with the fragments was taken in the hand and raised about 3 or 4 feet above the double funnel. The fragments were then allowed to fall, so that they struck the funnel on its inner surface, and passed through it. After this operation was repeated several times the funnel was tested by a quadrant electrometer brought to a very high degree of sensibility.

In the earlier trials some small deflections were obtained, but nothing worth attending to, and when greater care was taken in brightening the zinc, even these grew less. Similar experiments with copper were made, and with similar results. Although every precaution that I could think of for securing a correct result was taken, still I do not consider that such a negative result can be put forward as disproving Prof. Lodge's hypothesis. Nevertheless, I cannot help feeling support from it in inferring from the facts given above from Ayrton and Perry's tables that *contact electromotive force is quite independent of chemical affinity*. What the cause of such phenomena may be is quite another matter, but the notion (often set forth) that it is due to molecular motion receives great support from the fact of thermo-electricity.

But what of the galvanic battery? My answer is that its action has never yet been explained even by the chemical theory. The *locus* of the electromotive force has been sought at every junction—at the zinc-acid, at the copper-acid, at the zinc-copper. But it is clear that the D.P. which arises from these contacts on open circuit is not that which causes the continuous current, because the D.P. of nearly every battery alters when the circuit is closed. The D.P. on open circuit can give only a momentary current, and the continuous flow of electricity must be due to something occurring after the closing of the circuit.

What occurs? Sulphate of zinc is formed, hydrogen is set free, and other new substances are produced according to the nature of the battery. *I submit that the D.P. causing the continuous current is due solely and entirely to the contact of these new substances with one another or with the original materials of the battery.* The D.P. maintaining the continuous current cannot be due directly to chemical action, for if so the D.P. of all batteries in which the same chemical actions occur would be equal. But we know this is not the case. Chemical action is followed by electrical phenomena, but it is no more the cause of them than the motion of the trigger is the cause of the flight of the projectile. Sir Wm. Thomson uses the force of gravity to get a continuous current from the *contact* of copper and zinc. Messrs. Hugo Müller and Warren De la Rue make the contacts of the same elements for the same purpose by revolving machinery, springs, cams, &c. In the galvanic battery the contacts sustaining the continuous flow of electricity are due to the formation and liberation of new substances.

ON THE LIGHTING OF TRAINS BY ELECTRICITY.

IN view of the important progress, says the well-known *Zeitung des Vereins Deutscher Eisenbahn-Verwaltung*, which electric lighting has made in the last decade in respect of illuminating public thoroughfares, as well as dwellings and factories, it is not to be wondered that extensive experiments have and are being made in also applying the same for the lighting of railway trains. What the respective railway companies had in view was to obtain a light superior to that of gas, oil, or candles; and some companies have hesitated about introducing the costly plant for lighting by gas, as the electric light seemed but a question of time. There were, indeed, enthusiasts who maintained that not only would the trains be lighted by electricity, but the current might even be utilised for signalling on board, illuminating the track by means of powerful reflectors on the engine, and even in working the brake. Other companies considered the question one of fashion, the glow lamps contributing to make the train tasteful and attractive. Anyhow, in many instances, the railway companies have only sanctioned experiments at the urgent entreaty of certain electrical firms, who have had a firm belief in the future of the light. Lately, however, since the first clamour for the lighting of railway trains by electricity has subsided, the question has entered upon a new stage, chiefly through the recent accident at Wannsee, the danger of a gas explosion and fire in case of accident having proved very serious.

In view of the extent and variety of the experiments which have been carried out in lighting trains it is only natural that the results have been contradictory, and this must partly be ascribed to the difficulty in arriving at reliable figures, and partly to the different objects in view by the experiments. Thus, as long as the question was simply to light an elegant Pullman train the matter was much simpler than when it concerned the lighting of ordinary passenger trains and the reconstruction of the entire rolling stock of a railway to be thus lighted. Moreover, the results need necessarily be different, according to whether the installation was to be a temporary or permanent one. We consider that for Pullman, and similar trains, the electric light holds its own, but as regards the lighting of ordinary trains we confess the results seem to point in favour of gas. This should, however, not cause the discontinuing of further experiments with the electric light. Neither can it be said that recent experiments in signalling and the working of the brake by electricity have given results calculated to favour electricity.

This view is fully corroborated by the trials which have taken place of late years on the Würtemberg State railways. Up to 1886 the through express trains in Würtemberg were lighted by gas, and the ordinary trains by stearine candles, but in that year the electrical works at Cannstatt carried out some extensive trials with the electric light upon the State railways, which resulted so favourably that it was surmised that in a very short time the light would be introduced in all trains; but the result has been the opposite.

According to the estimates furnished by Prof. Dietrich and the Electrotechnical Institute in Cannstatt, the cost of installation and lighting a train of seven cars would be about £500, it being pointed out, also, that electricity would not furnish a stronger light than oil. Each glow lamp would cost 2·9 pfennings an hour, as against 3 pfennings, or more, for oil or other illuminants. So far, therefore, the electric light appeared more advantageous; and the last diet was also of opinion that further experiments should be carried out, and that the light had a great future before it.

However, the promises thus held out have not been fulfilled, the experiments carried out by the Cannstatt works, as shown by a recent official report, demonstrating that at present, at all events, the system is unsuitable for the lighting of ordinary trains. The chief objections are: 1. That the trains cannot without great difficulty be disconnected or cars added; 2. That the tending of the light would require a special staff and therefore increased expenditure; 3. That the dynamo absorbs a great deal of space. Moreover, the report shows that the installation of the light in all trains in Wurtemberg would cost about £72,000, although the Cannstatt works only estimate it at £53,000, whereas gas installation would only cost about £27,000, a difference, therefore, of £45,000; whilst, as regards the working expenses, it is extremely improbable that the cost of electricity would only, as asserted, amount to 2·92 to 3 pfennings per lamp an hour, but many years experience has conclusively proved that this is the exact cost of gas.

The question of electricity *v.* gas has therefore been settled for the present as far as Wurtemberg is concerned, although the Government has granted the Cannstatt Works permission to carry out any further experiments. It should be added that the experiments in Wurtemberg have extended over several years, and have been carried out with the greatest care and accuracy.

On other German State railways experiments have also of late been made with storage electricity, as, for for instance, in Prussia, and here, too, the result has shown that the electric light cannot, for the lighting of railway trains other than Pullman's, compare with gas for cheapness, security in working, and simplicity.

It will therefore be seen that as far as this country is concerned, a long time must elapse before the electric light will supersede gas and oil in the lighting of our trains, and we can calmly await the development of the question.

NEW ELECTRIC EXPLODER.

At the present time considerable attention is being devoted to the subject of explosions and shot-firing in mines. The merits and demerits of the various explosives have been, and are still, under discussion. This is especially the case as regards roburite, but so far the results obtained from experiments made with different explosives have not been entirely satisfactory. The number of accidents which are frequently taking place in mines is very large, and it has been with a view to avoid these that Messrs. Manet Brothers, French electrical engineers, have brought out an apparatus for the firing of shots by means of electricity. Strange to say these two gentlemen came to almost the same conclusions as a commission appointed by the French Government to inquire into the causes of the explosion of fire damp, and whose report has just been published and recommended in a circular issued by the French Minister of Public Works. This commission, which was presided over by M. Haton de la Goupillière and composed of MM. Mallard, Le Chatelier, &c., decided in favour of the absolute exclusion from mines of all kinds of ordinary fuses and high tension electric apparatus, such as induction coils, &c., and all sorts of apparatus which may give off sparks on account of the high voltage. The apparatus of MM. Manet consists of a low tension dynamo-electric machine which immediately transforms mechanical inertia into electrical energy. An electric bell is placed in the apparatus, and this is said to allow of the determining whether or not the circuit and the primary are in good condition. It is claimed for this machine, which only weighs 22½ lbs., that it will heat to a red heat a platinum wire 1 metre in length. This result is said to be exceedingly satisfactory, as it would require a battery of from 60 to 70 Leclanché cells to produce a similar effect. The great energy of this exploder has induced the inventors to take advantage of it by improving the state of platinum fuses by making them stronger, larger and more regular. It is stated that with this apparatus from 1 to 80 fuses can be simultaneously fired according to the length of the circuit, and with ordinary conductors having an E.M.F. of 100 volts, whilst with static machines a much higher voltage would be required. An experiment was made before the Société d'Encouragement with this dynamo-electric machine. In this case a 12 cm. wire was placed at the end of a cable having a resistance of 20 ohms, and was made red hot, the length of 1 metre of the cable being stripped of its insulation and put into water, and the 12 cm. wire placed at the end. This result is considered to be very satisfactory, but whether the claims put forward by the inventors can be carried out in practice remains to be seen.

ON M. H. HERTZ'S EXPERIMENTS.*

By M. JOUBERT.

Dr. Hertz, professor at Carlsruhe, published in the course of the year 1888—1889 some experiments of very great interest. I have repeated the greater number of them, with the assistance of M. de Nerville, at the Central Laboratory of Electricity in the Place Saint

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* Bulletin de la Société Internationale des Electriciens, July, 1889.

Charles. The large hall at the laboratory, which forms a rectangle of 15 metres by 14 metres, enabled me to reproduce them under very favourable conditions.†

The great interest of M. Hertz's experiments lies in the accurate information that we gain from them concerning the intervention of the external medium in electrical phenomena. The idea of this intervention is not new. After Faraday's experiments and Maxwell's theories, there remained no doubts upon this point in the minds of physicists; but the experimental proof was wanting, and this proof has now been given to us by M. Hertz's experiments. They show, in particular, that the medium which intervenes in electrical phenomena is the same ether that forms the seat of luminous phenomena; that the disturbances in both kinds are set up under the same conditions, and with the same rapidity; and lastly, that there is identity of nature between certain electrical phenomena and the luminous phenomena.

What is an electrical current? We do not know; but the following hypothesis gives us a very good idea of what occurs. Let us consider a conducting wire, in its natural condition, as connected to indefinite elastic cords, normal at its surface. To intodnce a current into the wire is to displace the wire in a direction parallel to itself and with the nature of the current, so as to draw with it the points of attachment of all the cords. These latter become oblique and remain oblique while the current is passing, but return to their original position and resume their normal direction as soon as it ceases. These cords being indefinite, the effect of the current makes itself felt at any distance, but evidently less and less, in proportion as the distance is increased.

But it is also very evident that the effect is not felt everywhere at the same moment; it arrives progressively at the various points, and takes rather more than 8 minutes to arrive at the sun. We may add that what is called the *coefficient of self-induction* is only the coefficient of the term that corresponds to this external work of the creation of the field.

It should be well understood that the phenomenon of which I have just spoken has not its analogy in luminous phenomena. In order to produce the resemblance, we must consider alternating currents. Let us introduce into our rectilineal conductor an alternating current of a sinusoidal form; the elastic cords will be drawn alternately into first one direction and then the other, and each one will be the seat of transverse vibrations propagated along its length. We will, according to custom, call length of undulation the path taken by the movement during a complete vibration backwards and forwards. It is under the action of these movements, transmitted through ether, that a conducting wire, stretched parallel to the first, becomes the seat of induction currents. We may remark that if this wire is stretched at a distance from the first equal to the length of undulation, it will give, at about the same intensity, the same phenomena of induction as if it were in contact; but that if it were placed at half this distance, *i.e.*, at a distance equal to a half length of undulation, the induced movements would be at each moment of a nature contrary to those produced in a wire adjoining the conducting wire, the only ones that we are accustomed to consider, and that the elementary laws of direct and inverse currents would be reversed.

The experimental verification of this fact would be the most direct proof of the propagation of the electric action; but if the rate of propagation is the same as that of light, viz., 300,000 kilometres per second, and if the period of our alternating current be $\frac{1}{100}$th of a second, the wave length will be 3,000 kilometres, and the distance of the two wires would be 1,500 kilometres.

In order to get a wave length of 3 metres the duration of the vibration must not exceed $\frac{1}{1000000000}$th of a second.

We cannot hope to produce directly alternating currents of such a short period; but we know that under certain conditions of resistance of the circuit the discharge of the Leyden jar is effected by isochronous vibrations of very short duration; but these oscillations have always been found to range from $\frac{1}{10000}$th to $\frac{1}{1000000}$th of a second. It is the same with the oscillations produced in the open circuit of the secondary wire of a Ruhmkorff coil at each interruption of the inducing current. This minimum duration of $\frac{1}{1000000}$th of a second corresponds to a wave lengh of 3 kilometres!

One of M. Hertz's great achievements is to have found a method by which still more rapid oscillations can be given, the duration of which may be reckoned in billionths of a second. Theory points out that if two spheres (fig. 1) charged at different potentials are put in communication by a conductor equilibrium is established by a series of isochronous oscillations, rapidly checked, like those of a liquid contained in communicating tubes, the level of which has been disturbed. The duration of the oscillation depends on the capacity, C, and the coefficient of self-induction, L, of the system, and is given, when the resistance of the joining wire may be disregarded, by the formula

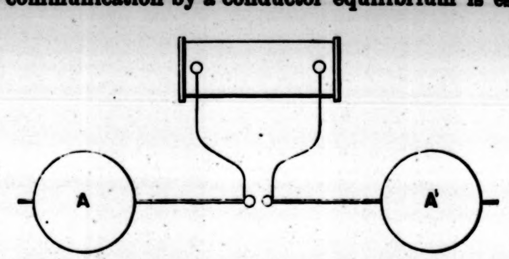

FIG. 1.

$$T = 2\pi\sqrt{LC}.$$

Such is briefly M. Hertz's apparatus, which we will call the exciter; it consists essentially of a rectilineal conductor cut in the middle and terminated at its extremities by two capacities, two large spheres or two plates.

In the apparatus placed before the Society the rectilineal conductor has a diameter of ·5 centimetres and a length of 40 centimetres; the two spheres are 30 centimetres in diameter. Consequently we get

$$C = \frac{15}{9 \cdot 10^{20}},$$

$$L = 400$$

$$T = 16 \cdot 10^{-9}$$

From this we deduce for the length of undulation, the speed being supposed to be that of light,

$$\lambda = 4 \cdot 80 \text{ metres.}$$

In order to realise the instantaneous charging of the exciter we leave an interruption in the middle, terminating the two opposite extremities by little balls and putting each of these balls into permanent communication with the two poles of a Ruhmkorff coil. The bobbin employed with the exciter in question is a Carpentier bobbin (type 600 fr.) working with a Marcel-Deprez interrupter and a current which is 15 ampères when the interruption is suppressed.

This is the action of the apparatus. At the moment when induction is produced on the secondary wire of the coil the two branches of the exciter which form the extremities are brought to different potentials, and at the same instant a bright spark flashes between the two balls, establishing during a very short period between these two balls a passage of low resistance, across which the rectilineal conductor discharges upon itself independently, almost as if it were separated from the bobbin. These oscillations are stopped before the following oscillation of the bobbin, which does not return until after $\frac{1}{10000}$th of a second has had time to take place, and they are renewed in the same manner at each oscillation of the bobbin. The condition of the exciter may be compared to that of a violin string, the vibrations of which are kept up by the sharp drawing of the bow.

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† The materials necessary for these experiments were very kindly supplied to us by Messrs. Carpentier and Lemonnier, and by the company for working metals by electricity. I take this opportunity of thanking them for their generous assistance. I must also express my sincere thanks to the young engineers at the laboratory, Messrs. Marganie, Dierman and Bary, for the help they rendered us throughout.

The essential condition of the phenomenon is therefore that the spark should pass and should be of the intensity required. If we separate the balls so as to suppress it and to leave open the secondary wire of the bobbin, we no longer get the proper oscillations of the bobbin, which are about 10,000 times slower than the proper oscillations of the exciter.

The production of rapid oscillations depends on complex and even somewhat mysterious conditions; they are influenced not only by the distance of the two balls, but also by the condition of the surface, the degree of polish of these balls, the dimensions of the bobbin, the intensity of the inducing current, &c.; a pretty strong violet light falling upon the balls completely puts a stop to the oscillations.

We know whether the apparatus is working well by the report and aspect of the spark; this spark is formed of very fine and very bright rectilinear strokes, giving rise to sharp crepitations.

The exciter naturally develops in the neighbouring conductors alternating induced currents. I established experimentally, in 1880 (Comptes Rendus de l'Académie des Sciences, Vol. XCI., pp. 408 and 493, 1880), the laws of alternating currents. I showed, in particular, that the circuit seemed to have, instead of its resistance, R (the *true resistance*), an *apparent resistance* equal to

$$\sqrt{R^2 + \frac{4 \pi^2 L^2}{T^2}}$$

In actual experiments, in consequence of the excessive smallness of T, the second term of the radical takes an enormous value, before which the proper resistance of the conductor may absolutely be disregarded. And thence arise several necessary consequences which impart to the phenomenon quite a special character.

In the first place the resistance of the conductor is of no importance; all else being equal the phenomena produced in a wire will be independent of the nature and thickness of the wire. In the second place, there will be established between two neighbouring points of the same conductor, which are separated by an apparent resistance which may be enormous, differences of potential out of all proportion to those that we generally observe. Lastly, that property of variable currents of penetrating only progressively the thick layers of the conductor will be carried to its extreme, and the electrical movements will be solely superficial.

In fact, when the apparatus is working well, as at present, and the oscillations are produced, there is not in the room or in the adjoining apartments any piece of metal, large or small, insulated or in communication with the earth, from which we cannot draw sparks. We see them flash between the two extremities of a wire which we curve into a bow, between two pieces of money, or two keys that we bring together; we obtain them by presenting the point of a knife from the gas pipes, water pipes, &c.

In order to analyse this phenomenon M. Hertz uses a wire bent into a ring, the extremities of which can be brought together at will. We observe the sparks which pass between the extremities of the wire, and we judge of the intensity of the phenomenon by the explosive distance and by the brilliancy of the spark. On trying rings with different diameters we find one with which the sparks take their maximum length; it is then that the period of the electrical movement excited in the wire which constitutes the ring is the same as that of the exciter; the ring acts as resonator. And, in fact, if we take a frame of the same diameter, but in which the wire makes several turns, we obtain much feebler sparks.

With a resonator well in accord the sparks are from 8 to 10 millimetres in the neighbourhood of the exciter; they decrease rapidly when the distance increases, but they are still visible at 15 or 20 metres from the apparatus.

I hoped to render these phenomena visible to an audience by employing a frog, but the frog gives absolutely nothing.

Instead of M. Hertz's ring, M. de Nerville and I have employed a rectilinear resonator composed of two rods, formed of two copper wires, placed end to end, the extremities of which bear capacities consisting of sheets of tin (fig. 2).

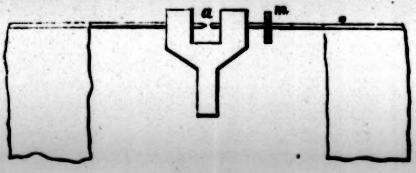

FIG. 2.

We determine by trial the length of the wires and size of the sheets of tin most suited to our purpose. At the interruption, *a*, one of the wires is rounded, and the other cut to a point. The system constitutes a species of micrometer; one of the wires bears a screw-thread, and the explosive distance is made to vary by turning the milled head, *m*.

The spark flashes in the space between the two wires. When the exciter is working in the large hall of the laboratory, and the length of the wires and the size of the capacities are well regulated, we observe very brilliant sparks, which attain to 7 or 8 millimetres in the neighbourhood of the exciter, and which are visible in all the other halls, in the yard, in the street, and even at a distance of more than 50 metres and through several walls.

This apparatus leads us to a very curious experiment, showing plainly the influence of light on the production of the oscillations. On bringing the resonator near to the exciter, we see that the character of the spark of the exciter changes, and at the same time the spark of the resonator disappears. On interposing any screen whatever, the phenomenon reappears in all its brilliancy. A sheet of glass has the same effect as an opaque screen; but, on the contrary, the interposition of a thin sheet of quartz, which allows a violet light to pass through, does not re-establish the phenomenon. The spark of the rectilinear resonator is at its maximum when the resonator is parallel to the exciter. The spark is nil when the resonator is in the symmetrical plane of the exciter, but when turned a few degrees we see the spark reappear.

A stone wall acts in the same way as a transparent plate as regards the undulations, and we can hardly note any difference between the sparks obtained on the different sides of the wall. A metallic plate acts like a glass very slightly silvered; it reflects part of the wave, but lets a very considerable part pass through; thus the sparks are still very appreciable behind a metallic surface formed of a sheet of tin or a plate of zinc of ·5 millimetres, or even of a plate of iron of 3 millimetres. These figures are simply the thicknesses of the plates tried, and they have no other meaning. It is probable that we should obtain a more complete reflection with plates of greater thickness or greater conductivity.

I come now to one of M. Hertz's fundamental experiments, that which demonstrates in an undeniable manner the existence of the waves in question. It is an experiment exactly analogous to that by which Savart showed the interference of direct sound waves with waves reflected by a wall. The bottom of the hall was covered with plates of zinc, forming a metallic surface of 4 metres by 6 metres, and the exciter was placed opposite to it at the other extremity.

The vibratory movements provoked by the exciter are reflected upon the metallic surface. By well-known mechanism, the reflected waves, interfering with the direct ones, give rise to stationary waves separated by fixed nodes. And, in fact, if we place the resonator very near the wall we only see faint sparks; they increase when it is drawn away, attain a maximum, then go on decreasing and finally disappear at a distance of about 2·4 metres, to reappear again. Thus, there is a first node in contact with the wall, as is the case with sound waves when the reflection takes place with change of sign, and a second at a distance of 2·4 metres. The distance corresponds to half a wave length. If we take in the duration of the vibration as calculated above, *i.e.*, 16 billionths of a second, we deduce from it that the rate of propagation is 300,000 kilometres, *i.e.*, that of light.

Thus the vibratory electrical movements, and the vibratory luminous movements, are propagated with the same rapidity. They answer, then, to a modification of the same nature of the same medium. The only difference is in the duration of the period. We can easily obtain electrical vibrations of a billionth of a second, and consequently wave lengths of 30 centimetres. The length of undulation of the visible rays is on an average ·00005 centimetres; that is, 600,000 times shorter. M. Hertz carried still further the analogy between the two phenomena, and we have repeated the greater number of his experiments. Unfortunately, they are too delicate to be shown in public, and I can only invite the members of the Society to come and see them at the laboratory in the Place Saint Charles.* I will now merely indicate the principle of them. An exciter with a very short period is placed according to the focal line of a parabolic cylinder, having a height of 2 metres, with an opening of 1·20 metres.†

The area in which the phenomenon is appreciable, and in which sparks can be obtained with the resonator, is limited by two vertical planes passing through the edges of the mirrors, and parallel to the axis of the parabola of the base. We get thus a true parallel electric ray, similar to the luminous ray that would be given by a source of light placed in the position of the exciter. By receiving this ray upon a second mirror, similar to the first, we may repeat the well-known experiment of the two conjugate mirrors, and show that the vibratory movement is concentrated upon the focal line of the second mirror. We may also reflect this ray upon a plane, and show that the angle of incidence is equal to the angle of reflection. We may also make it pass through a prism, show that it deviates towards the base of the prism, and from the deviation deduce the index of refraction of the substance for the electric ray. M. Hertz made this last experiment with a prism of asphalte. This is the only one that we have not been able to repeat, for want of a prism of sufficient dimensions.

The President warmly thanked M. Joubert, and congratulated him upon the charm which he has imparted to his communication upon a subject of the highest scientific interest. He adds that the members of the Society ought to congratulate themselves on the fact that their laboratory has enabled these remarkable experiments to be realised.

THE INSTITUTION OF ELECTRICAL ENGINEERS IN PARIS.

A JOINT meeting of the "Société Internationale des Electriciens" and of the Institution of Electrical Engineers took place the 24th inst. in the large amphitheatre of the "Société d'Encouragement," Sir **WILLIAM THOMSON** in the chair.

Colonel **SEBERT**, President of the "Société Internationale des Electriciens," being invited to speak, he, sitting in his chair, read a short speech, in which he paid a tribute to the Institution of Electrical Engineers for their foresight in organising nearly 20 years ago an electrical society, of which the present institute is the outcome; also for the part which they took in the Congress of 1881, and which augured very well for the 1889 Congress then to be opened. The Colonel concluded by saying that he himself took the English Institution of Electrical Engineers as a model, and by welcoming the other electricians from all countries, amongst whom he was glad to name Mr. Edison, as the representative of America, and who was expected to take his seat on the platform during the proceedings.

Professor Sir **WILLIAM THOMSON**, rising to respond, said, in French, that he begged, in the name of all his English colleagues, to thank Col. Sébert for the kindness shown by him to the English institution and the English electricians. He was, himself, glad to recall the support given by France to science, and the application of science to practice, and to refer to the various Congresses and Exhibitions held in that country.

Having said this much, the learned professor, after having asked Col. Sébert to be allowed to speak in English for the benefit of those of his hearers who did not understand the language of the "Grande Nation," and leave being, of course, gracefully granted, he created a little merriment amongst the French listeners when he announced in French that "he would come down to his own language," which he expressed by "Je descendrai à ma langue propre," the same being an equivalent, to French ears, to "I will go down to my clean tongue."

The learned *savant* said that he had something to say in a very few words about the 1881 Electrical Exhibition, but these few words merged into a very prolific speech. Sir William said the 1881 Exhibition was the first electrical exhibition known, and was conceived in the spirit characteristic of the French nation..

This was followed in quick succession by the London, Munich, and Vienna Electrical, Exhibitions, but that of 1881 was unique and a characteristic monument of faith in great things to come in applying scientific principles to practice, a prophecy of what was coming and a monument of what had been done. Carrying his mind further back, he could not forget the feeling of astonishment which he expressed when he saw the Gramme machine for the first time in 1871 at Thomas Andrews's, of Belfast. This learned chemist and physicist was demonstrating Lacour's discoveries and had, on his lecture table, two Gramme machines in series, one being an exciter and the other a motor.

The Gramme machine was the first step and realisation of an electric machine on an economical scale and for practical purposes. It was shown in 1881, Siemens's electrolysis machines were also exhibited on this occasion, so was the Edison machine (now known as "Jumbo"), which was much admired and wondered at for its huge proportions and the large quanity of work which it could do.

In 1881 also was shown Faure's battery, the eulogium of which could not be adequate to its importance as a discovery. The Faure battery was a thing of the past, but not to be forgotten. It was the stepping stone of what was going to come.

In 1883 took place the conference in which units and names to be given were fixed. Most important profits have been derived from its labours; workmen and users of electricity, both scientific and unscientific, use the technical terms currently and talk of voltage and current as freely as they would talk about steam pressure.

The **PRESIDENT** concluded by saying he looked forward to the Electric Congress with bienveillance and, continuing in French said: "Je regrette de n'avoir, pour exprimer ma pensée, pu me servir que de mots si faibles et si . . . . stumbling." The audience laughed and gave the president the hearty applause which he so richly deserved; but on being reminded by Mr. Preece that he had forgotten to mention the incandescent lamp, he rose up again and said that of course Edison and Swan incandescent lamps were a noticeable feature of the 1881 Electrical Exhibition. Electric lighting is a thing of the household; it is better than the bougie, paraffin, and the moderator lamp.

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* An extra *séance* took place at the Place Saint Charles on Friday, July 12th, for the repetition of these experiments.

† We are indebted for these mirrors to the kindness of M. Lemonnier.

The arc light is not banished nor destined to be ever banished by the incandescent light. Edison and Lane-Fox were the first to fully grasp the conditions of subdivision fulfilled by the system of incandesence, and Edison and Swan were the first to realise them. The arc lamp will continue to be used in cases where subdivision is not required; the object of the incandescence is to have a large number of small lights, and it would be an anachronism to have lighting of 50, 100, or even 200 candles done by arc light. Sir William then referred to the first arc lamp invented, which he saw used at Foucault's for showing the bright light of the spectrum in spectroscopic analysis, and which soon after came into practical use for lighthouse purposes. He mentioned the great improvements due to Mr. V. Serrin's ingenuity, and to the Serrin and de Méritens arc lamps, also shown in 1881, and brought his speech to a conclusion by saying that the arc lamp still holds its position, and always will, for lighting where subdivision is not wanted.

M. **Mascart** offered his best thanks to the organising Committee of the Congress, whose labours were terminated, and saw in Sir William Thomson's presence a guarantee that the present congress would be full of interest. The initiative taken by the British Association in reforming and creating measures is a page of contemporaneous history. The telegraph, the telephone, the electric light are spreading over the whole world; no civilised being is out of their reach, and this owing to words briefly conveying their meanings, such as volts, ampères, ohms, pressure, output, canalisation, &c.; a consequence of which, added M. Mascart, with a touch of sarcasm, has been to cause the metrical system to cross the Channel, and he sincerely hoped that our *voisins d'Outre-Manche* would in time, when the transformation of habits is a fact, and owing to the services rendered by the system, accept it. M. Mascart concluded by saying that the Congress could take up with interest such questions as the mode of exploitation and the administrative questions in electric lighting. He paid a tribute to Faraday, Clerk Maxwell, Franklin, and Edison. Mr. Edison was still expected, but had not arrived.

The next speaker was an inventor, who summarily described his process of manufacture of artificial silk, copied from nature. The specimens which he circulated in the shape of skeins, ribbons, printed and other goods, were very much appreciated, and especially by the feminine portion of the audience. The inventor explained that the only reference his process had to electricity was that the silk so manufactured was as good an insulating material as natural silk, and he could also, by his process, produce threads $\frac{1}{1000}$th of a millimetre in diameter, which could be usefully employed in the suspension of some delicate electrical instrument.

M. **Carpentier**, the well known electrical instrument maker, was then invited to explain his melograph, which he did in a very comprehensive and interesting manner. This clever apparatus, which electrically records anything played upon a piano connected with it by conductors, and by the same means utilises the said printed records to reproduce the tone, has been described long ago in all technical papers. An amusing incident occurred at this moment; the artist engaged to play on the piano, and whose tone was going to be registered as a demonstration, struck up "God Save the Queen;" the British portion of the audience sprang to their feet, the French portion following out of compliment, and Edison, who had just arrived at 9·45, made a quite unnoticed entrance amongst the whole audience upstanding. He reached the front rank without anybody being aware of his presence, and took his seat on the platform in the midst of the commotion caused by the sitting down of the whole room. This is how he accidentally escaped an ovation which might have been as warm as it was deserved, as the mention of his name in his absence had already been very warmly received. The phonograph was then made to play a splendid march, which created enthusiasm.

The *seance* terminated, and the visitors remained late in the room of the "Société," where a show of interesting instruments had been prepared for their gratification; some telephonic auditions from the Comic Opera being listened to in a room where 20 pairs of telephones were available. A well appointed and patronised buffet, where "real champagne," as Prof. Hughes put it, was freely dispensed, completed the list of entertainments.

Amongst the exhibits were a number of delicate registering apparatus relating to the firing of guns, the speed of shots, &c., due to Col. Sébert, and well known to all the specialists; Mr. Napoli's rotary photometer; Mr. Crompton's patent armature winding, illustrated by bundles of copper bars showing a section of armature winding for a 1,000 ampère machine, subdivided and twisted to prevent Foucault's currents; a portable form of potentiometer, having a 4 metre bridge with multiple switch, so that 6 separate E.M.Fs. can be compared with a standard Clark cell, exhibited and manufactured by Crompton and Company, Limited; Capt. Renard's portable battery lamp (a number of which had been used during the evening), each weighing 16 to 17 kilos, and discharging nominally at 4 to 4·5 ampères, with a difference of potential at the terminals of 10 to 12 volts for a five hours' duration of lighting; and Messrs. Richard Frère's now well-known registering instruments; amongst these was a current registering instrument for guaranteed canalisation, with which a contractor can detect any undue current sent through his cables, and repudiate any further guarantee.

Amongst the English members of the Institution of Electrical Engineers were noticed Profs. Sir William Thomson, Forbes, Hughes, Perry; Sir Douglas Galton, Major-Gen. Webber, Capt. E. H. Verney, &c.; Messrs. A. R. Bennett, L. Drugman, E. Graves, C. G. Gumpel, A. Stroh, E. Wilmore, W. H. Preece, John Aylmer, Richard Aylmer, J. Farquharson, A. Bagnold, M. B. Gisborne, R. A. Scott, R. W. Wallace, G. Chatterton, J. H. Webb, Langdon Davies, C. E. Spagnoletti, G. Muller, H. E. Starr, A. Turner, J. Frayssinier Gotendorff, and J. A. Berly.

THE EXPERIMENTAL DETERMINATION OF THE LAW OF VARIATION OF THE ELECTROMOTIVE FORCE IN THE ARMATURE OF A WESTINGHOUSE DYNAMO.*

By LEWIS SEARING and SAMUEL V. HOFFMANN.

In the mathematical discussion of alternating currents, it has been customary to assume the law of variation of E.M.F. as that of a sinusoid. Previous experiments to determine this law have been made upon machines containing *no* iron in the armature. Recently, Dr. Louis Duncan, of the Johns Hopkins University, has conducted experiments in which he found that this assumption was approximately true with the Siemens machine.

We propose to investigate this law upon a machine *containing* iron in the armature. To observe the effect produced by varying the conditions, we imposed the following:—

(1) Field current ... 2·15 ampères; load = 0; speed = 1,000
(2) „ „ ... 4·3 „ „ = 0; „ = 1,000
(3) „ „ ... 4·3 „ „ = 0; „ = 1,000

The machine used was the No. 1 Westinghouse dynamo in the electrical laboratory of the Stevens Institute; rated at 65 horse-power, and requiring a current of 7 ampères in the field, when run at its full capacity.

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* Abstract from Graduation Thesis at Stevens Institute of Technology, Hoboken, N.J.

The power conveniently available being only a 35 horse-power Buckeye engine, accounts for the small figures taken for the conditions.

METHOD.

The method used was suggested by Dr. W. E. Geyer, of the Institute, who had employed it as early as 1881 on a continuous current machine. It consists in measuring the difference of potential existing between the brushes for an instant of time, at any angular position of rotation of the armature, by charging a condenser and discharging it through a high resistance galvanometer.

In the practice of this method it was necessary to devise some means of closing, for an instant, the shunt circuit across the brushes to the galvanometer, while the armature was in the desired position of rotation. To effect this, the following apparatus was devised:— A ring of brass, R (fig. 1), was sprung around the turned portion of the bearing nearest the pulley, and to this was secured the piece, A, to which, at B, was hinged the piece, C, held against A by a spring, and adjustable outward by the screw, D. At the upper end of C was secured a block of hard rubber, E, and to this was fastened the plate carrying the steel wire spring, F, by which contact was made with the steel piece, G, highly tempered and ground to an edge in the direction of its length. The steel piece, G, was fastened to the end of the armature furthest from the commutator, with its ground edge parallel to the shaft by means of a V-shaped brass, H, and at such a distance from the shaft as to just pass, in its motion with the armature, the contact spring, F. In holding H to the armature, hard rubber was used as an insulator and electrical connection made between it and one of the commutator rings by a rubber-covered wire running through the air space in the armature. Fastened to the bearing of the machine was a graduated arc of 120°, concentric with the brass ring. A pointer, P, on A, served to determine the angular position, in degrees, of the armature at the moment of contact, at which time the E.M.F. existing in the armature was measured.

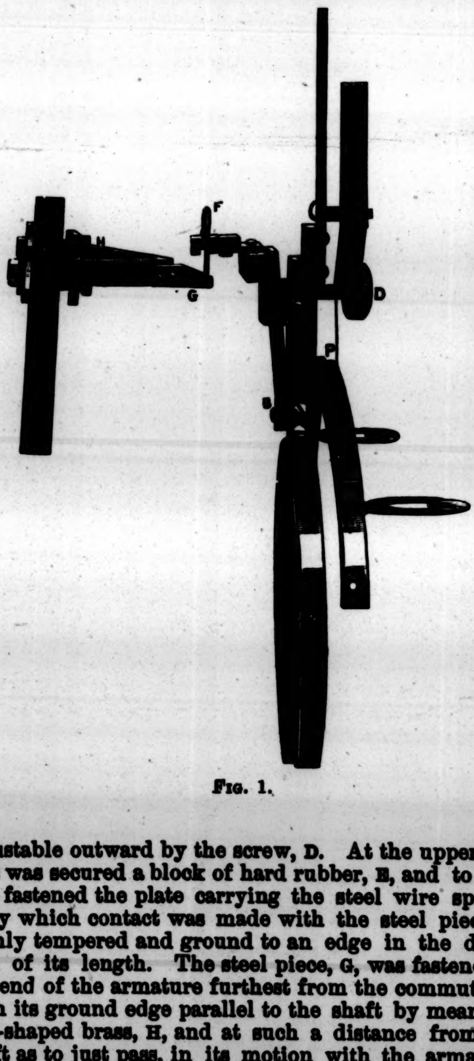

FIG. 1.

The contact spring, F, as finally adopted, consisted of a steel wire 0·034 inches in diameter, bent as shown in fig. 6. One end was inserted in the hole, K, and secured there by a set screw, and the free end passed through a hole, slightly larger than the wire, at J, sufficiently far to make contact with the rotating piece, G.

Fig. 2 is a diagram of the connections. A represents the wire of the armature; B, B_2, the brushes; M, the main circuit; C_1, the steel contact-piece revolving with the armature and connected with B_1. C_1 makes connection with the condenser, C, once per revolution by coming in contact with the steel spring, C_2, connected with the condenser by the line wire. B_2 is placed in connection with the condenser by the wire and the discharging key, as shown.

The necessity of placing the measuring instruments a considerable distance from the dynamo introduced a difficulty in the shape of self-induction, due to a long line. This we overcame as much as possible by using bare copper wire 0·008 inch in diameter. This line was supported on glass rods, fastened to wooden supports, except for a distance of 7 feet where they were fastened to a pine board for protection, and for about 4 feet where they passed through glass tubing. The wires ran parallel 4·5 inches apart their whole length, a distance of 150 feet.

The measuring apparatus used was a "high resistance Thomson reflecting galvanometer," with its accompanying shunts $\frac{1}{9}$, $\frac{1}{99}$, $\frac{1}{999}$, and two mica condensers of one microfarad capacity (variable, &c.), all by Elliott Bros., London. The scale used with this galvanometer was placed 33 inches from the needle, and had divisions measuring 40 to the inch.

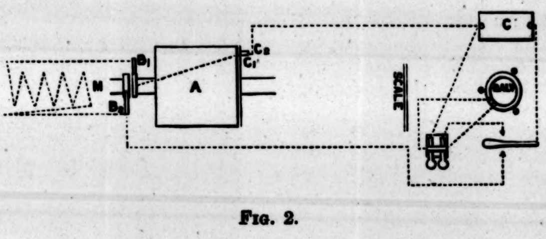

FIG. 2.

The first difficulty experienced in measuring was that arising from the large static charge induced in the line wires and the metal of the machine by the action of the belts. The first step towards removing this was to connect the body of the machine with the ground, and to furnish pointed wire collectors to the belts, also connected with the ground. Although this removed much of the charge, there still remained enough to charge the 0·1 microfarad condenser, and give with the one-ninth shunt a mean but not very constant deflection of 21 divisions. As 1 volt gave a deflection of about three divisions with the one-ninth shunt, this would have seriously interfered with our measurements. At first, it was a question whether we were measuring the potential of the condenser due to the static charge, or that due to the dynamo. The following considerations, however, show that we were really measuring the E.M.F. of the dynamo; for, suppose the condenser had become charged from the belts, &c., to a potential *greater* than that which the armature would furnish, then, as soon as the contact piece completed the circuit which includes the condenser and armature, the condenser would, by reason of its greater potential, immediately discharge itself through the armature until its potential equalled that of the armature, which is the E.M.F. we would measure. If, however, the condenser was charged to a potential *less* than that of the armature, then upon completing the circuit, the armature, from its being able to supply an infinitely larger current than the belts, &c., would charge the condenser instantly to its own E.M.F., which is what we measure, as before. Moreover, our experiments showed that, in this particular case, the current from the belts required quite a perceptible time to charge this condenser, and give even a measurable charge. An additional fact that no error was introduced by this static charge is evident from the regularity of the readings and the smoothness of the curves.

The order of procedure in applying this method was as follows:—The dynamo and instruments for measuring potential being about 150 feet apart, in separate rooms, the observers in each room were connected by telephone and bell. The dynamos being started and everything made ready, signals were exchanged to that effect. Then the observer in the dynamo room adjusted the contact apparatus for the first position, numbered 12°, observed the indication of the ammeter in the field circuit, which if not as desired, was made so by adjusting the resistance in that circuit, rang "go ahead" signal to the observer in the measuring room, and upon receiving his answer, threw in the speed counter and noted the time. The observer in the measuring room, immediately upon answering the "go ahead" signal, commenced a series of measurements of E.M.F. of the condenser, by noting the swing of the galvanometer needle as follows:—The charging key was placed in "charge" position and left there a few seconds. One reversing key was then closed and almost simultaneously the condenser was discharged through the galvanometer. As soon as the galvanometer needle came to rest, another charge was measured. These measurements occupied from three to four minutes. Upon the completion of each series of experiments, "go ahead" was signalled to the dynamo room for the contact to be changed to the next position, and the above operations repeated. Speed was usually counted for three minutes, or nearly the whole time of measuring, and therefore the average speed for each series was obtained quite accurately. The variation in the field current during a series was never over 0·2 of a division = 0·04 ampère, hence no correction has been introduced for this. The speed in some cases changed quite perceptibly. To be able to make a correction for this, we determined the law of variation of E.M.F. with the speed in this machine. To do this, we made simultaneous measurements of speed and E.M.F., the latter at position of contact apparatus which gave the highest readings, *i.e.*, 34°, a point in the upper part of the curve. This law, as represented by a curve, showed a direct variation, it being almost a straight line. Upon this the corrections for speed were made, the value of the E.M.F. being computed for 1,000 revolutions per minute.

At the beginning and end of each run, which occupied about four hours, any variation of H was observed by noticing the swing of the needle produced by the condenser when charged from a cell of a Leclanché battery, kept especially for that purpose. The variations were so slight that they have not been introduced in our corrections.

The corrections to be applied to the readings of the galvanometer were:

1. A geometrical one, from the fact that the swing of the spot of light measures the tan 2 a, while the charge is proportional to sin $\frac{1}{2}$ a.
2. A correction due to the induction of the shunts.
3. A correction for the ratio of the shunts.
4. The resistance of the air to the swing of the needle.
5. The correction for speed.

The first, second and fourth corrections were obtained in one experiment, by comparing six gravity E.M.F. cells, which were approximately of the same E.M.F. by the condenser method. Then by using one of the shunts employed in the regular work, we noted the swing produced by 1, 2, 3, and so on, cells coupled in series. Knowing the exact comparative values of E.M.F. which the coupled cells ought to give, and by experiment the swing they did give, and taking the latter for ordinates and the former for abscissæ, we obtained a curve for converting the one into the other. This curve approached very closely to a straight line, the ordinates (or galvanometer readings) of which are about four per cent. greater than the abscissæ (or E.M.F. values). This correction was made graphically.

The shunt ratio and induction correction were obtained in one experiment, and amounted to 0·76 of one per cent., which was neglected.

The correction for speed was also made by the graphical method, and afterwards tested by logarithms.

The instrument used for measuring the field current was a portable Thomson galvanometer, and for measuring the main current of the Westinghouse, the Westinghouse ammeter usually accompanying the machine, which was previously calibrated by a continuous current. This instrument could not be relied upon within 0·25 of a division with the current we used.

The main circuit was through a large German silver rheostat, strung overhead in the dynamo room. When running at night, some of this current was used for lighting.

SPRINGS.

Upon the apparatus for obtaining almost instantaneous connection between the armature and condenser, or, more strictly, upon the pieces which come into such rapid contact, 1,000 per minute, depends the success of this method. Our difficulties and the manner of overcoming them may be of assistance to others. In the first arrangement of these pieces, the end of the brass V, H, fig. 3, which was fastened to the revolving armature came in contact with the spring, F, made of a strip of spring brass, $\frac{3}{8} \times \frac{1}{64}$-inch, and bent in the form shown in the figure. With this spring the wear was such as to cut through the thin brass in about two hours, and as this wear materially lengthened the arc of contact, we were compelled to abandon it. We then replaced the brass spring with pieces of clock spring, of several widths and thicknesses, tempered throughout, softened at ends, softened at the middle, and softened throughout; but even the most durable of these did not last over an hour. The majority of them broke at S. We then tried the brass spring again, this time capped with steel at its point of contact to prevent wear. This lasted about two hours. We next tried a heavy brass spring ($\frac{1}{2} \times \frac{1}{32}$), tipped with steel, made as shown in fig. 4. The part A has a spring outward and is held in check by B. The object of restraining the outward tendency of A is an important one, and is to shorten its time of vibration to much below 0·001 minute. The next arrangement is shown in fig. 5. The piece, H, in passing struck against a steel pin, which action forced

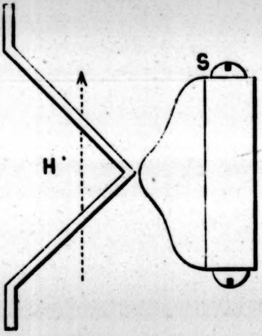

FIG. 3.

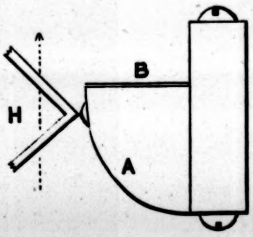

FIG. 4.

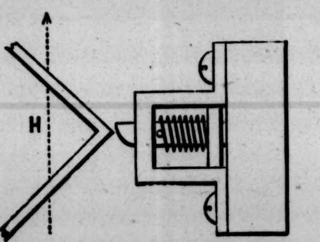

FIG. 5.

it inward against a light spring coiled about it. This arrangement produced such a jarring and such a wear on H as to make its use impracticable. From the experience of these springs we learned the causes of failure; one, that the springs used were much too heavy, and another, the most essential, that the path of the contact point of H was parallel to the surface of the part with which it came in contact, producing a direct blow and slide; whereas the path of each should have been tangent to each other, in order that the parts would approach and immediately recede, thus allowing, by means of the adjusting screw, a contact of almost any delicacy. The longer the arc of contact, the result of construction or wear parts, the greater the variation between readings taken at any point in the curve. To prevent this we arranged to have a knife-edge of hardened steel strike the end of a very light steel wire spring (·034 inch diameter), as described in a former part of this paper.

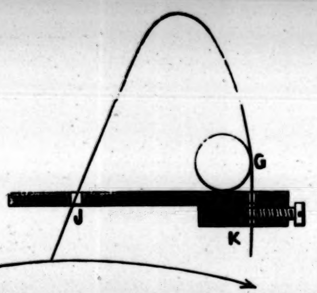

FIG. 6

The first spring used was bent, as in fig. 6, but without the coil at G, and broke at the point where it was clamped by the set screw, before the end of a run. We then coiled it twice at G, care being taken in fastening it to have the coils press firmly against the plate, in order that the bending should be confined to the coils. These springs would last about six or seven hours, and were readily and accurately replaceable; so, to avoid the annoyance of breakage, a new spring was used for each run. We then obtained a clear yet light contact that was in every way desirable.

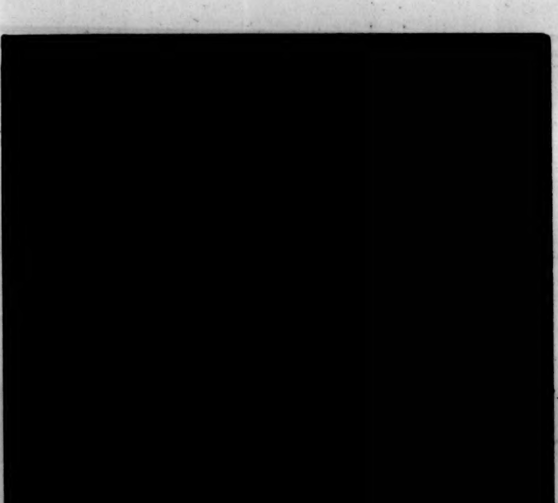

FIG. 7.

CURVE OF WESTINGHOUSE DYNAMO AT ABOUT ONE-THIRD LOAD.

Curves were taken under the same conditions, in pairs, so as to verify each other, and then the mean readings of the two plotted, as in fig. 7. In order to show how closely the curves follow the "sine law," a sinusoid has then been traced over them and is the inner line, and, as will be seen on inspection, the agreement is quite close.

The figure shows only one branch of the curve. Over this curve has also been traced a parabola, the focus being at the point O. While the curve cannot be said to follow the "parabola law," as it has two branches, the parabola is much nearer the true curve, for one branch only, than the sinusoid.—*Franklin Institute Journal.*

CONTINENTAL NOTES.

[FROM A CORRESPONDENT.]

A SYNDICATE has been formed in St. Petersburg for the purpose of establishing a new telegraphic agency in that city to compete with the indifferently managed Northern Telegraph Agency. The Minister of the Interior has approved the articles, which, among others, provide that in case of a war with Germany or Austria the messages are to be transmitted *viâ* Denmark or Switzerland.

The two firms in Berlin paying the largest amount of taxes are the Imperial Continental Gas Company with £25,000 a year, and the Berlin Electricitätswerke with £4,500.

An examination of the Accident Prevention Exhibition in Berlin, now open, does not reveal any new safeguards as regards electrical machinery. They consist solely of a careful insulation of coils and the covering of brushes and poles. However, some rough carbon points for lightning conductors are exhibited which are being much commended, but it is doubtful whether they indicate any novel progress. On the other hand, Messrs. Siemens & Halske exhibit a large quantity of all kinds of electrical apparatus to prevent accidents, by warning signals.

Apropos of lightning, an interesting correspondence has been published between the Magdeburgh Fire Insurance Company and Dr. Stephan, head of the German postal and telegraphic service, respecting the relation between the telephone and the electric fluid, from which it appears that, contrary to the general belief, experience in Germany goes to show that a telephone net rather acts as a protection against lightning than otherwise. For instance, in Hamburg, during the period 1885–88, there was only one case of lightning in the heart of the city, where the net is very dense, but many others in the suburbs where there is no telephone. In Berlin and other German towns, as well as in Copenhagen, similar experiences are reported. Dr. Stephan, however, points out that the Imperial Telephone net is being laid with every care, and that the number of lightning conductors is very large.

A telephone is to be laid between Frankfort-on-the-Main and Nuremberg, in Bavaria.

The Berlin Telephone Exchange now regulates the office clocks of their subscribers by means of the telephone wire. By an ingenious apparatus all the clocks are set right at noon from the central station, when the circuit is again closed.

The superiority of the electric light over gas and oil does not by any means appear to have been settled as yet in Germany, as, for instance, at the Hagener central station, in Westphalia, Siemens's regenerative gas burners have been substituted for the glow lamps hitherto in use, on account of the unsteady light of the latter, whilst at Frankfort from two to six powerful reflecting petroleum lamps have been fitted under the huge electric chandeliers at the new central station, which are lighted every night. At the central station at Strasburg, however, only the electric light is used.

In a recent number the *Bulletin International de l'Electricité* complains of the composition of the electrical jury at the Paris Exhibition, as of the nine jurors and three vice-jurors, seven represent telegraphy, meteorology, and instruments of measurement, whilst two represent industrial electricity, such as dynamos, regulators, &c., two the financial side of electricity, and one being the assistant engineer of the City of Paris. However, there is no one representing batteries, accumulators, the telephonic science, glow lamps, or conductors. "Why," exclaims our contemporary, "does not the jury number men among them like Messrs. Monnier, of the Ecole Centrale, and Hospitalier, of the Ecole Municipal, two of the most prominent specialists of the day in these branches of electrical science?"

An instance of the progress made in electro-technical science is furnished by the installation just completed for lighting and transmission of power in the South of France at the neighbouring towns of Dieulefit and Valréas, situated 21 kilometres apart, and having their common electrical source of supply at Béconnes, situated 15 kilometres from Valréas, and 6 kilometres from Dieulefit. The supply of electrical power is excellent in both places. The lighting installation has been effected by an electrical firm in Lyons, and the apparatus manufactured by the Edison Company, of Paris. The motive power is water, of which some 300 horse-power are at disposal, but as yet only a part is required.

In Switzerland, too, two waterfalls are to be used as motive power for transmission of electricity, namely, at Klus, on the river Aar, and at Lartze, by a company from Zurich. At the Hotel Bernina, at Samarten, in the Engadine, which has for some time been lighted by electricity furnished by a neighbouring waterfall, the proprietor has hit upon the ingenious idea of utilising for cooking the force wasted in the day. Other experimental cooking apparatus has been constructed, containing German silver resistance coils, which are brought to red heat by the electric current, and all the ordinary cooking is now being done in a range fitted with a number of these coils.

The Municipal Council of the City of Athens has decided upon erecting a miniature Eiffel Tower in the great square in front of the Royal Palace, whence the latter and adjacent thoroughfares are to be illuminated by a single powerful electric light.

A correspondent of a Danish journal gives the following curious particulars of his being struck by lightning. He was standing near a house with an open umbrella in his right hand when struck, which was felt like a stunning blow, whilst all around him seemed a sea of fire, as he felt the electric current rush through his body. He was semi-conscious, and on opening his eyes found himself stretched upon the ground. By degrees he was able to move his limbs, except the right arm, which first felt burning hot, then icy cold. However, by incessant massage he regained completely the use of his limbs. His watch had stopped, and could not be made to go again. In several places on the right hand there are white blisters of various size, whilst under the right and left foot are also blisters, causing a burning sensation. The electric fluid had entered the right arm through the umbrella and passed through the body and out at the feet.

When an electric current, says a French contemporary, is led through the leaf of a rose it loses its colour, leaving a white line. This peculiarity was recently turned to account at a great dinner in Paris, when, instead of the ordinary card, the seat of each guest was indicated by his name being inscribed in white letters upon a rose leaf in his *couvert.*

General Mensier, Director of Engineering at the French War Office, being greatly interested in the application of electricity in the army, has ordered the officers of *corps d'armée* to study the use of electricity for the lighting of forts, barracks, arsenals, and military buildings generally. A first trial of the electric light has been made at Epinal for the Bonnard Barracks. As the result, the experiment proved that four men taken from the telegraphists of the regiment were sufficient to assure the working of the machines. The net price of an eight-candle lamp is twice less than that of the old petroleum lamp, which was so dangerous; and three times less than that of gas.

In connection with the recent stormy weather, the French Post and Telegraph officials have issued the following notice:—"The atmospheric state still influences the aerial conductors, but the situation has improved. The interior and foreign offices have their normal communications nearly assured; those of a few secondary offices still remain interrupted. There will be a certain delay, but much less than before."

Several offers relative to the distribution of electricity in Brussels have been received and examined in the offices of the Communal Administration. It is anticipated that a decision will be arrived at during the first few days of the sitting after returning from the vacation.

During the Belgian autumn manœuvres a detachment of military telegraphists will be attached to each division. The offices will remain open day and night. The field telegraphists on Saturday opened up communications between the headquarters of the 3rd division with the cantonments of Heinsch and Stocken. Some details as to the laying of cable lines, which will this year replace line wires, may be of interest. For each line all that is necessary for the construction is—nine cable reels, a telegraphic-telephonic office, and the various tools and accessories. The cable used is formed of a copper wire enclosed in a plait of iron wire, the whole being insulated by means of gutta-percha. The construction of a line requires a staff composed of an officer, a junior officer, three corporals, and eight men. The cable is laid along the route at the bottom of dry ditches and culverts, or is suspended on trees or other natural supports. On arriving at the destination, the telegraphic-telephonic office is installed. The system of telegraphy to be employed is that of Van Rysselberghe, to which have been added some ingenious innovations, which claim Commandant Waffelaert and Lieutenant Tollen as their authors. The time necessary for the construction of a line varies greatly according to circumstances and the nature of the ground. If the cable be laid on the ground, about 15 minutes per kilomètre is necessary; if it be suspended, an average of 25 minutes for the same length is taken. In places where the telegraph waggon cannot pass, a transport wheelbarrow is used. A corporal, who is appointed to see whether the line is well constructed or not, follows the waggon five minutes after its departure.

The partisans of all schools of magnetism will hold, in Paris, from October 21st to 27th, an international congress for the study of animal magnetism applied to the relief or cure of invalids. The subscription, which is fixed at 10 f., will confer the right of taking part in the different works of the congress and to receive the publications and *comptes rendus.*

The question of the electric light is still being actively considered by the Paris Municipal Council. At a sitting just held, before separating, it adopted the proposed terms of subscription; the leading feature of which is the decrease of the price in proportion to the increase of consumption, the maximum being 2½d. per 100 watts hour. This progressive decrease is the best encouragement to the development of electric lighting. The question of the alternating current machines to be acquired for the Municipal works was also discussed. Two competitors were present: M. Pantin, representing the Ferranti machine system, and MM. Naze and Dandeu, who appeared with machines of their own construction; the first being of English origin and construction, the others of French. After a long and lucid explanation as to the experiments which had been made, the Council ratified the purchase of the English machines and transformers of the same system. On the proposal of M. Dumay, the purchase of the cables necessary for high tension currents was voted, at an estimated expense of 150,000 francs. The tendering for the high tension cables lay between the General Telephone Company, the firm of

Menier, and the India-rubber and Gutta-percha Company. The Council adjourned its decision relative to the extension of sections which had been asked for in connection with the new demands for section lighting, presented by M. Berthier and by MM. Nouvelle and Geisenberger. The discussion led M. Alphand, Director of Works, to speak on the lighting of the districts bordering on the Champ de Mars *apropos* of the lighting of the Exhibition. He hoped that that would create a competition on account of the probable preservation of a part of the Exhibition buildings on the Champ de Mars, a preservation voted in principle before the separation of the Chambers. The consequences of this decision would be the maintenance of a part of the electric stations which serve for the lighting of the park, and which probably would be charged with the lighting of the roads leading thereto.

EXECUTION BY ELECTRICITY.

The opposition to execution by electricity in America has been supported by many men who have brought forward various pleas why the death sentence on a criminal should not be carried out by means of the electric current. The first opponents promulgated the idea that it would be sheer sacrilege to prostitute the heavenly and sacred fluid to such a base use as the intentional deprivation of a fellow-creature's life. The next stage of attack formulated as a ground for the non-employment of electricity for the purpose, a fear that a growing industry, which was becoming a commercial success, would be thrown back for years, and, perhaps, totally ruined. That the imagination of the public would be so strongly excited by the thought that the same current which was adding to the publics' safety and comfort by its power of producing a brilliant light, had been, and was being debased to the standard of a common hangman; that the minds of most people would be over-wrought by a species of haunting terror and horror, and the hiss of every arc lamp, or the hum from an alternating current machine, would appeal to them as the death-knell of some miserable being, until in the end a whole city would present the appearance of a huge charnel house, where each electric light would seem to be a corpse light hovering over a victim's grave. As the result, an almost total abolition of electric lighting and power, with their attendant advantages, might be looked for. This class of objection to electrical execution, while piling up the agony as to the direful effects to be anticipated from a few executions carried out nearly in private in the recesses of a gaol, credits the public with a remarkably long memory in the one case where a worthless criminal is to be operated upon, and this, too, with the operation performed with the utmost scientific care to ensure the death of the culprit in an infinitesimal part of a second; on the other hand, when the executions take place in the light of day, and more frequently—we refer to the numerous accidents caused by currents of high potential—the people have been lulled into a sense of false security by the statements of the electrical companies that this sacrifice of life is unavoidable, and that no industry of equal dimensions is attended with fewer casualties. As far as can be judged it is not the customers' nerves that are on the rack, but those of the representatives of the electric lighting companies who have the wholesome dread, that once the public is awakened to the fact of the serious danger to life from the careless use of a certain class of electric current, the companies will be compelled to remedy the defects in their installations and leads, at a heavy cost, and with a prospective reduction in their dividends for some time to come. "That's what's the matter!"

Legitimate argument failing to disprove the advantages of capital punishment by electricity, either on the score of certainty of result, or that it is not in every way an improvement on the process of hanging, opposition to the electric method is still raised in asserting that death by the electric current, though produced instantaneously, is accompanied by such exquisite torments that no one but a fiend, or a professional torturer, would dare to advocate its use even in the case of a most atrocious criminal.

Another plea has been forthcoming why the condemned man Kemmler should not suffer death by the new method. Mr. F. A. Wyman, of Boston, in a paper read at a meeting of the National Electric Light Association, entitled "The Constitutionality of Execution by Electricity," maintains that the law passed by the New York Legislature is of no account, as under existing State constitutions, with only a few exceptions, legislatures cannot authorise and courts cannot inflict such punishment. Punishment is meted out to a criminal to deter him and others from committing like offences, and to protect society; to gain these ends he should suffer for his misdeeds, but punishment should go no further. All acts of the legislature must harmonise with the constitution or be null and void. Constitutions are simply articles of partnership, and all living under it are partners (some active, some silent), and are working under the partnership articles. *Constitutions* can be made or altered only by the direct voice of the people through the channels provided by the instruments themselves. *Laws* are made by bodies of men chosen for brief periods on account of their ability to cope with a general variety of subjects, and who are sworn to support and uphold the constitution under which they are acting.

The people of nearly every State have placed limits upon the power to punish for crimes. The Constitution of the United States, following the wording of the declaration presented by the English Houses of Parliament to the Prince and Princess of Orange, on February 13th, 1689, declares that cruel and unusual punishment shall not be inflicted.

In the "Report of the commission to investigate and report the most humane and practical method of carrying into effect the sentence of death in capital cases," appointed in New York in 1886, the following list is given of the various modes of capital punishment:—*Auto da Fé*, beating with clubs, *beheading*, *decapitation* (these latter two means of execution appear to be a modern instance of the St. Patrick's birthday controversy), blowing from cannon, boiling, breaking on the wheel, burning, burying alive, crucifixion, *decimation*, *dichotomy* (to perform either of these operations on one man would require the skill of the begging soldier, who being promised a shilling if he could prove his military knowledge by forming fours, did it), dismemberment, drowning, exposure to wild beasts, flaying alive, flogging, knout, garrote, guillotine, hanging, *hari kari*, impalement, iron maiden, *peine forte et dure*, poisoning, pounding in mortar, precipitation, pressing to death, rack, running the gauntlet, shooting, stabbing, stoning, strangling, suffocation. We are not surprised that, after reading the above delightful list of ways of terminating existence, the humanitarian members of the New York Legislature should have passed an Act making execution by electricity the legal mode of capital punishment. It is contended that death by electric current is both cruel and unusual, and therefore the power was wanting in the Legislature to over-ride the Constitution by passing such a law. Many cases are quoted to show what may be, or may not be, considered cruel and unusual punishments.

A judge of the Supreme Court of New York said:—"It is difficult to define by a general definition the phrase 'cruel and unusual punishments,' Acts are startling only by comparison, and what may be cruel in one state of society is not so in another. Evidently, then, the law of the State of New York prescribing punishments for crimes committed within a certain locality must be judged by its own general standard. Its right to change such general standard is unquestioned."

"The courts have seldom had occasion to construe the meaning of the phrase 'cruel and unusual punishments.' The text writers . . . . seem to understand it as prohibiting any cruel and degrading punishment not known to the common law, and probably also those degrading punishments which in any State had become obsolete when its existing constitution was adopted, and punishments so disproportioned to the offence as to shock the sense of the community.

The following punishments have been held not to be cruel and unusual:—Disfranchisement and forfeiture of citizenship; labour on the public streets; cumulative punishment; fine and imprisonment; imprisonment for 10 years of a man suffering from epilepsy; fine of 1 cent and three years in county jail for an assault with a cane; fine of $50 and three months' hard labour for selling intoxicating liquors; corporal chastisement on the bare back.

Only two cases are cited as instances of cruel and unusual punishments:—

1. A man whipped and kicked his wife; on his trial the judge sentenced him to five years' imprisonment in the county jail.

2. This was the case of a Chinaman sentenced to have the hair of his head "cut or clipped to a uniform length of 1 inch from his scalp;" this punishment was declared cruel and unusual, because there was no doubt the Chinaman would have preferred torture to the punishment which entails disgrace upon him in the eyes of his own countryman.

From these data, Mr. Wyman deduces his conclusion that electrical execution is an unusual punishment and consequently under constitutional prohibition; he also maintains that it is cruel; he paints the agony of a prisoner on being put into the rack (for it is no more or less than a rack) upon which he is to be killed at some time, perhaps ten minutes, perhaps an hour; he persists in asserting that no living man can tell how much electricity will kill a man, as he had lately seen a man who had received the full force of a 2,500 volt current, and yet was alive and well. The shock had produced insensibility for some time, but during the interval between the shock and the unconsciousness, the man realised he had been struck by some terrible force. If the rack now proposed comes into use for holding a convict in position preparatory to the death stroke, it is not improbable that many culprits will die from fright, without even connecting the paraphernalia with a dynamo. The question now is, whether the Courts of New York will pronounce such punishment unconstitutional, because it is cruel and unusual? The author of the paper thinks he has shown that punishment of death by means of the electrical current is so cruel that the legislature ought not to adopt it, so cruel that the legislature of New York ought to repeal the law, and so cruel that the Courts of New York ought to pronounce the statute unconstitutional.

Dr. Moses, in flowery and gushing language, depicted the frightful pain to which the human frame is subjected by powerful electric shocks, together with the uncertainty of their effects on different snbjects: relates how Benjamin Franklin accidentally received a shock from 2 six gallon Leyden jars, and was knocked senseless, on recovery stating that his whole body had undergone a "universal blow," but that he did not hear the sound of the discharge although the bystanders declared it to be as loud as the report of a pistol. In one breath, Dr. Moses declares that punishment by electricity should not be allowed on account of its cruelty, and then that the punishment of a criminal should be attended by a considerable amount of pain, from which we would infer that he was in favour of capital punishment by electricity.

A resolution was moved to petition the New York legislature to repeal the obnoxious Act.

The only Philistine who spoke in opposition to the unanimous opinion of the mutual admiration society or National Electric Light Association, was Dr. Fell, who said that Wheatstone had demonstated the speed of the electric current to be about 280,000 miles per second; that the nerve current progressed at a rate of some 111 feet a second. Now, as the nerve current is the speed of sensation, so that when an electric current is passed through the body, is it possible for the nerve current to overtake it?

Prof. Anthony demurred somewhat to this statement, as it was perfectly understood that Wheatstone's experiment was unreliable, and that it was not the speed of the electric current that was measured, but simply the time required for those wires to be charged and for a spark to leap across the gap between the two wires.

We are afraid that in the opinion of the meeting, Dr. Fell, or rather let us say the facts brought forward by him, occupied the unenviable position described by Martial in his epigram—

> Non amo te Sabidi . . . .
> . . . . Non amo te.

We still think that Harold Brown's side of the general argument is the more tenable.

THE BIRMINGHAM EXHIBITION.

(*Continued from page* 205.)

THIS exhibition continues to make progress, the number of admissions being very satisfactory. On Saturday last over 10,000 passed the turnstiles, and at certain times the doors had to be closed to prevent overcrowding. The telpher line, which from easily imagined causes was unavoidably rather behindhand, is now open for traffic, and doing good business. The carrying capacity consists of six skips, each seating two persons, sitting face to face, so that 12 passengers are taken at each trip. Now that royal princesses have at considerable discomfort descended a real Welsh coal mine, no doubt there will be an increasing number prepared to run the risk of a descent into the mimic pit at the Exhibition, which affords all the novelty and excitement of the real thing, without any of its danger and unpleasantness.

Electrical Power Storage Company.—Some pains have been taken to make this exhibit a representation in miniature of the prominent position occupied by the company, as manufacturers, in one of the most important departments of the electrical industry. Many forms of the E.P.S. accumulator are shown, including special cells for central station lighting, for general and private house lighting, for ship and yacht lighting, and for the lighting of trains and vehicles. Others are adapted for traction purposes and for launches. Automatic switches and cut-outs, the E.P.S. regulating switchboard and sundry other appliances are also included. The E.P.S. accumulator cell for central station lighting is in use by the Chelsea Electricity Supply Company, the Cadogan Electric Light Company, the City of Westminster Electrical Syndicate, and others. At the station of the Chelsea Electricity Supply Company, the storage battery consists at present of 8 sets of 54 L 31 cells in glass boxes, which are of the latest form, or 1888 type, in which the plates are supported clear of the bottom of the containing vessel by means of feet at the bottom corners of the spongy lead plates, and the peroxide plates are carried on an insulated saddle bar, forming a metal connection along the edges of the spongy lead plate.

C. A. Muller.—This gentleman contributes two handsome glass cases, one containing specimens of the electric measuring instruments manufactured by Schuckert, of Nuremberg, and the other filled with samples of the electric light carbons made by Schmelzer, of Nuremberg.

Walter T. Glover & Co. show a large collection of examples of wire and cable insulated in various ways to meet the general and special requirements of telegraph engineers, telephone companies, and electric light contractors. An old telegraph pole is shown with insulators, shackles, &c., as are also samples of the whole of the wire and cable used in the Fine Arts and Old Manchester sections of the Manchester Exhibition. There are special cables made for electric lighting on board ship, and for use with secondary generators or transformers, and a number of flexible non-inflammable cords for electric lamps. The firm has a patent composition for covering iron wire to protect it from the atmosphere and the action of the smoke and fumes from chemical and other works. This is found to increase the life of a line by three or four times, the extra cost being soon saved in maintenance alone. In telephone work this covering preserves the wire and prevents the annoyance of contacts. Patent anti-induction telephone cables, and examples showing the progress made in their manufacture also form part of this very complete exhibit.

John Fowler & Co.—Samples are exhibited of the lead covered cables and wires manufactured by this company by Tatham's patent process. These cables, which can be made of any length, are in use in different parts of the kingdom for all kinds of underground work, telegraphs, telephones, electric light, and transmission of power. They are well adapted for ship work and for use in mines. The dielectric of these cables has very high insulation resistance combined with great mechanical strength, so that they can be used to work at very high electrical pressure. The inductive capacity of the telegraph cables is said to be lower than that of gutta-percha covered cables, admitting of an increased speed of working on underground lines. It is stated that the anti-induction telephone cables of this make are giving particularly good results.

Acme Electric Works.—This is a good miscellaneous display of apparatus and appliances used in telegraphy and electric lighting. Mr. Cockburn's patent cut-outs made to suit various currents, and his patent reliable switches are of course prominent features. There are, however, many other things equally necessary in every installation such as the spring ammeters and voltmeters made under the patents and special certification of Messrs. Ayrton and Perry, and their new form of hot wire instruments. Royce's dynamos are shown driven by a Griffin gas engine affording light for this and adjacent stalls.

Electro-Plating.—There are some excellent exhibits by Birmingham firms of electro-metallurgists who show the process of electro-plating to any visitor prepared with an article to be operated upon "while you wait." Messrs. J. E. Hartley & Co. have at their stall samples of all the chemicals and other requisites of the trade, and some specimens of metal work coated with their transparent enamels and hard cold lacquers. The "Wonder" and the "Little Wonder" are two appropriately named plating dynamos of American manufacture, for which Messrs. J. E. Hartley & Co. are agents. Messrs. W. Canning & Co. (sole agents for Hemming's dynamos) and Mr. R. Cruickshank also have fine displays of goods used by electro-platers and polishers.

THE SWISS-GERMAN RHINE CANAL COMPANY, BIRSFELDEN (BASLE). ISSUE OF 11½ MILLION FRANCS.

[FROM A CORRESPONDENT.]

UNDER this title there has appeared in several Swiss newspapers and in the *Frankfurt Zeitung* a prospectus, issued by the Finance Committee of the above company, from which I extract the following portions:—

"The falls of the Rhine are utilised by means of turbines guaranteed by the Augsburg Machinery Works, and Bell & Co., Kriens Nagel and Kamp, of the Hamburg Iron Works, to give a useful effect of 77 per cent. The gross water power is 9,440 horse-power, and consequently the power obtained at the turbines = 7,000 horse-power. This power is conveyed electrically to the different work places. Allowing a loss of 25 per cent., 5,000 effective horse-power can be made available for the production of power and light. The industrial region of this station works with about 10,000 horse-power, and about 3,000 horse-power are further required for the production of light, so that there is a two-fold opening for the utilisation of power.

The erection of the works, with all the machinery, which will be supplied on hire to subscribers, will cost 11½ million francs. This sum, calculated in percentages on the capital, is divided as follows: 4 per cent. acquisition of land; 6 per cent. the acquisition of rights and easements, including 13·87 of land legally secured; 42·6 per cent. earthworks, masonry, and stone-cutting; 21 per cent. electro-technical expenses; 7 per cent. for turbines, sluices, transmissions, &c.; 1·3 per cent. machinery, houses, and offices; 1·1 per cent. oversight whilst building; 17 per cent. other items, interest whilst building, unforeseen outlays, &c.

This sum is based upon binding guaranteed agreements, and shares to the value of 3 million francs have been definitely taken up. For the fisheries and the purchase of land agreements have been concluded with private possessors and with communities.

Appendix.—On August 15th, offers have been handed in for four million additional shares.

The undertaking shows:

Yearly Outgoings.	Frcs.	*Yearly Receipts.*	Frcs.
Sinking fund for machines	170,000	*For power.*	
Do. for 11½ millions at ½ per cent....	57,000	2,500 horse-power at 3,000 hours at 0·08 f.	600,000
Lubricating and care of machines	60,000	2,500 H.P. at 5,000 hours at 0·08 fr. ...	1,000,000
		For Light.	
Cleaning canal	20,000	15,000 glow lamps at 30 frs.	450,000
Wages and salaries ...	70,000		
Laboratory	10,000		
Unforeseen	13,000		
Total	Fr. 400,000	Total	Fr. 2,050,000

that is a net gain of 1,650,000 francs, or 14·34 per per cent. on capital.

The shares, 500 francs each, are issued at 110 per cent. (the agio being explained by the considerable preliminary costs, investigations, and financial advances), and the payments will be 20 per cent. on allotment, and the rest as may be required during the two years estimated for the completion of the works, but generally only 10 per cent. on each call. In the meantime 5 per cent. interest will be paid on all capital paid in. In German money 100 francs = 81 marks. The distribution of the profits will take place according to section 9 of the Companies' Law, *i.e.*, 10 per cent. to the reserve fund, 5 per cent. to the council of management, and the rest as will be resolved by the general meeting.

The shares will be quoted on the Bourse. In case of an excess of applications, a proportionate reduction will be made.

Basle, *August*, 1889.

Even a passing glance at the above schedule of the probable outlay and returns shows with what censurable superficiality this imposing project has been treated whilst the public is being invited to subscribe. It can scarcely be assumed that, as the prospectus says, the capital for the undertaking is secured by the taking up of shares for three million francs, and that, as it is announced in mountebank style, applications for four million more shares "have just come in." The credibility of these assertions is placed in a very questionable light.

It is said, namely in the prospectus, that the financial committee have deposited considerable sums with the Commercial Bank of Basle as a guarantee. Hereupon there appeared in the *Allgemeine Schweitzer Zeitung*, on behalf of the Commercial Bank of Basle, on August 22nd, an explanation in the following words:—

"In the prospectus of the Swiss-German Rhine Canal Company of Birsfelden (Basle), it is said that the firms concerned have deposited with the Commercial Bank of Basle considerable sums as a guarantee. This induces us to explain that hitherto no moneys have been deposited with us on account of the above-named company."

At the same time three firms mentioned in the prospectus in the *Frankfurt Zeitung*, *i.e.*, the Hildesheim Bank, the firm Nathan & Co.. of Fürth, and the firm W. Gerolle & Co., of Landshut, have published an explanation disclaiming all connection with the undertaking.

Under such circumstances we are surprised to find the name of a firm like the Thomson-Houston International Electric Company, of Hamburg, figuring in the financial committee, and, in the interest of the reputation of this firm, we must assume that they have got into the prospectus without their knowledge, like the guarantee deposited at the Basle Commercial Bank, and like the three others just mentioned.

Such an assumption seems, in so far, plausible, if we consider the style of this firm as printed in the prospectus. In the prospectus it is given Thomson-*Horsley* instead of Houston, and we can scarcely assume that one and the same printing fault could occur both in the *Frankfurt Zeitung* and the *Schweitzer Allgemeine Zeitung*.

It would be very deplorable if the electrotechnical industry, which, after such long struggles against the distrust of the financial world, has at last found favour and an equal rank with older branches of industry, should, by such treatment, be again discredited.

NOTES.

Electric Lighting at Bournemouth.—At the last meeting of the Bournemouth Commissioners the Clerk reported with reference to the recent communications from certain electric lighting companies, that he had replied to each of those companies, asking for information as to what they proposed doing in the matter. Only one, however, had sent a reply, and it appeared to him the Commissioners were not at present in a position to decide what course they should adopt. He thought it would be advisable to adjourn the matter for a month to see if further information turned up. He had requested from each of the companies a copy of the provisional order which they proposed to apply for to the Board of Trade. Mr. Ridley considered the matter required very great caution, and he proposed that it should be postponed until their first meeting in October. Mr. Hankinson seconded, at the same time remarking that he was not disposed at present to favour either of the applications. This course was adopted.

The Electric Light v. Gas.—In the course of a report which has recently been prepared for the information of Bournemouth ratepayers with reference to the local gas company, the surveyor says that a very natural fear exists that the more extended use of the electric light may seriously affect the value of the gas undertaking. However, to those who had acquainted themselves with what had already taken place, this fear would appear groundless. The general experience had been not only in England, but also in the United States (where the electric light was used more generally than in any other part of the world, and where gas was considerably dearer than in this country), and on the Continent, that the use of the electric light does not seriously affect gas. The surveyor adds, "The electric light is the light of luxury, and is never likely to be introduced into ordinary dwellings, which will always require gas for lighting, heating, cooking, and other purposes."

The Electric Light in Sheffield.—A special meeting of the Town Council will be held on the 25th of September next for the purpose of considering an application from the Sheffield Telephone Exchange and Electric Light Company, Limited, for the consent of the Corporation to application being made to the Board of Trade for a licence to supply electricity.

Huddersfield Corporation and the Electric Light.—The Corporation have decided to oppose the application of the various companies for the lighting of the borough, and to ask for a provisional order to supply electricity themselves.

Calcutta and the Electric Light.—Messrs. Crompton and Company's representatives in Calcutta have obtained sanction to a scheme for the lighting of this place by electricity.

Electric Lighting in Newcastle.—We understand that the Newcastle and District Electric Lighting Company, Limited, has received intimation from its representative in London that the terms of licence for lighting this city with electricity have now been practically settled with the Board of Trade, and therefore the company expects to be in a position to commence the laying of the main cables almost immediately. Great inconvenience has been suffered by the company through so long a delay in procuring the license, without which it was unable to lay its cables. The machinery and plant, however, are now well forward, and the company intends to push the work vigorously, so as to be able to supply current to its customers before the end of next month.

Avery Hill and the Electric Light.—The light is to be laid on to Avery Hill, Chislehurst, Colonel North's Italian Palace, which we hear is rapidly nearing completion.

Electric Lights in Naval Warfare.—During the early part of the week one of the flagships in the naval manœuvres had three attempts made upon her by torpedo boats, but they failed through the search lights on board the vessel showing them up too plainly. Shortly afterwards, however, according to the *Standard's* correspondent, the dynamos for these lights collapsed. If this had happened half an hour earlier it might possibly have meant the sinking of the ship. This mishap occurred in exactly the same way last year, and that it is due to the flimsy manner in which these machines are fastened to the deck. It would be better, thinks the correspondent, not to fit appliances of this kind at all to old vessels, if they are liable to fail at any critical moment.

The Liverpool Inspector of Electric Lighting.—As we have already stated, the Watch Committee of the Corporation of Liverpool received 47 applications for the position of inspector of electric lighting, at a salary of £150 per annum. This number was reduced to five a week ago, and, after some consideration, the appointment was given to Mr. C. H. Yeaman, assistant electrician to the Ward Electrical Car Company, Limited, London.

Mill Lighting at Chelmsford.—Messrs. Christy and Norris are busy arranging for the installation of the electric light at Messrs. T. D. Ridley and Sons' flour mills. The light will be in use in about a month's time.

Leicester Town Council and the Electric Light.—The Gas Committee recommended the Council to authorise that application be made to the Board of Trade for a provisional order to enable the Corporation to supply electricity for the borough. On Tuesday the Council met to consider the report, and in moving the adoption of it Councillor Lennard considered the interest of the consumers would be better looked after under such a system than by allowing a company to have the monopoly. After some discussion, the motion was carried *nem con*. Leicester has at last come to the conclusion that the supply of electricity is a practical question.

The Telephone in Switzerland.—The cheapness of the telephone service in Switzerland has led to its general adoption, the annual cost being about £5 a year. Last year upwards of 65 towns were provided with telephone service, bringing the total number of stations to 6,944. We might add that the Government has charge of the telephone service, which is under the control of the Department of Posts and Telegraphs.

Overhead Wires.—We shall be pleased to receive the opinions of any of our readers who feel disposed to favour us with their views on the rules and regulations compiled by the Board of Trade for overhead wires. There may be a number of points of importance which we have overlooked in our comments, and we should therefore feel much gratified if our attention is called to anything which is deemed of importance.

The Fêting of Mr. Edison in Paris.—Mr. Edison was entertained on Wednesday evening in the Pavilion of the British Section by the members of the Executive Council. Among those present were Sir William Thomson, Mr. James Dredge, of *Engineering*, Mr. Preece, Sir Douglas Galton, and others.

Electric Shares in Japan.—The following appears in yesterday's issue of the *Financial News* :—In Japan the problem of making a fair allotment of shares in a public company has been brought to the front through a rush for the securities of local industrial enterprises. The Nippon* Electric Light Company, of Tokio, offered 4,000 shares of 25 yen, or about four guineas, each for public subscription. Applications were received for 12,000 shares, so it had to be arranged that no one living in the district to be served by the company should have more than 50 shares, and that no more than five should be allotted to individuals living elsewhere. That was an eminently fair way of arranging an allotment, but it could hardly be applied to breweries or nitrates.

Scenery by Electric Light.—A novel use is made of the electric light on the St. Lawrence River, near the Thousand Island resorts. One of the lights has been placed at the end of a yard arm on the steamer *St. Lawrence*, which has a dynamo aboard. The light stands in front of a powerful reflector, and as the boat steams about at night among the islands the search light is cast upon them, revealing with startling distinctness their beauty and the beauty of the landscape.

Submarine Telegraph Enterprise.—*Engineering* says: During the first half of this year the Anglo-American Company's repairing steamer, *Minia*, has been engaged in repairing the Tricore cable, and the north and south Placentia cables, between Newfoundland and Nova Scotia. She has also repaired the Salcombe and Brest cable on behalf of the Submarine Telegraph Company, and has partially renewed and diverted the St. Pierre and Duxbury section

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Electric Railway Statistics.—Mr. Bracken states, in his paper on "Electric Traction by Storage Batteries," that he wrote to nearly everybody in Paris, England, and his own country, who have been, or are, engaged in storage battery traction, but that only one reply reached him. We know at least one individual, with perhaps the greatest experience of any man on this side, with whom Mr. Bracken did not correspond.

Birmingham Exhibition Notices.—With reference to our notice of the exhibits at the Birmingham Exhibition, we are requested to state that the art metal fittings on view at Messrs. Appleton, Burbey & Williamson's stall, No. 72, are exhibited by the Brompton Electric Fittings Company, Limited, of 146, Brompton Road, London, S.W., Messrs. Appleton, Burbey & Williamson having been appointed as the company's agents at the Exhibition.

University College. Dundee.—The calendar for the seventh session, 1889-1890, is just published. The Principal's report for the last year records a satisfactory advance in the number of students, and it is stated that the engineering laboratory, now open to the use of the students, will bear comparison, in point of accommodation and equipment, with any institution of the kind.

Concession for Cables by the Government of Costa Rica.—The Government of the Republic of Costa Rica has authorised M. D. V. Cuenca Creus, concessionaire for the submarine cable from Venezuela to the United States, to establish telegraphic communication, either direct or indirect, with a point on the eastern side of the Republic on the Atlantic Ocean, by means of one or several cables. This cable will be able to touch one or more places in Central or South America which are not yet in telegraphic communication with the Republic of Costa Rica by the Atlantic Ocean, and the concessionaire will be obliged to connect his system to the transatlantic cable, which is projected between the Island of Cuba, Spain and France, by way of the Canaries. The Government of Costa Rica guarantees an annual revenue of 35,000 francs, and reserves to itself the right of intervention in the formation of the tariffs and regulations.

Electric Punkah Alarm.—The news comes from Madras of an invention for checking the sleeping propensities of the punkah coolie. Around the outer edge of the punkah wheel are placed metal tongues, revolving freely on pivots, which are inoperative so long as the wheel is in motion, but as soon as it stops fall down so as to complete the circuit of an electric current which rings an alarm bell, and startles the coolie out of his nap. The apparatus can be fitted to any ordinary punkah, and will make it impossible for the "man at the wheel" to go off to sleep for a single second.

Proposed Electric Railway.—We understand, says the *Contract Journal*, that a private company has been formed with the intention of constructing an electric railway from the town of Lanark to Hamilton, the motive power to be obtained from Stonebyres, one of the series of the Falls of Clyde. The object is to afford the people of Lanark a more direct journey to the city, *via* Hamilton, than by way of Carstairs Junction. The capital has, it is said, been subscribed.

Telegraph Money Orders.—Amongst the advantages which the Postmaster-General has long been urged to confer upon the public is the means of insuring the payment of money at post-offices by telegraph. Mr. Raikes has seen his way to some extent to gratify this desire, and from the 2nd of next month it will be possible at many places to succour a friend in need by immediately placing £10, the highest amount which may be sent, at his disposal. The boon is one which has long been demanded, and will, of course, be keenly appreciated by persons who sometimes get into sore straits, but it is doubtful whether it will be used to any very great extent. The official *Gazette* contains the regulations as to telegraph money orders.

A Vice-President of the Edinburgh Exhibition.—We hear Mr. Edison has consented to act as one of the vice-presidents of this exhibition.

Engineers' Stores.—We have received from Messrs. W. H. Willcox and Co. a useful catalogue of engineers' goods, including belting, pulleys, lubricating oils, lathes, drilling machines, India-rubber goods, and all the various essential accessories of the engine room and workshop. Willcox's dynamo oil, and special oil for gas engines, are probably well known to most of our readers, and it would appear that the firm is giving special attention to the requirements of electricians in other directions.

Telegraph Clerks' Overtime Work.—Twenty-two notices of motion for next session have been given, and among them is one by Earl Compton, calling attention to the overtime work of telegraph clerks in the central telegraph office, as to which he will move a resolution.

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* Should not this read "Edison"?—Eds. E Rev.

The Safety of Edison.—An American journal says if Edison is not very careful an English syndicate may get hold of him and prevent his return. Our transatlantic contemporary is evidently unaware that we are quite contented with his carbon transmitter and incandescent lamp, without having the inventor here himself as a probable bone of contention in a fresh lawsuit between rival claimants for his possession.

E.P.S. System of Electric Supply.—The Electrical Power Storage Company is circulating a beautifully printed pamphlet, with diagrams, descriptive of the Storage System of Electric Supply as now in everyday operation by the Chelsea Electricity Supply Company. Major Marindin, Board of Trade Inspector, in his evidence before the Select Committee of the House of Lords, expressed the opinion that "from the consumer's point of view there is no system which gives so good a supply as the direct current and storage batteries," and that he believed the system adopted by the Chelsea Company was the best. The pamphlet fully describes the system, estimates the cost of plant, of maintenance and of depreciation, and against these calculates the revenue to be expected at 8d. per Board of Trade unit. The conclusions arrived at show a good margin of profit on the required capital for central stations so operated.

India-Rubber, Gutta-Percha and Telegraph Works Company.—A new list of electric wires and cables is just issued by this company, giving particulars and prices of all the standard sizes of which stock is kept. They are divided into classes according to the insulation, ranging from conductors formed of plain copper wire, covered with prepared tapes, up to those of tinned copper wire, insulated with, first, pure rubber, then vulcanised rubber, then rubber coated tape, the whole being vulcanised and enclosed in lead. In all cases only the best and most durable rubber is used for insulating purposes, any extra cost thus caused being compensated for in the lengthened life of the cable.

Electricity in Rufford Abbey.—Lord Savile has had the light laid on in the Abbey. Every corner of the place has been favoured, utilising 400 lights supplied by a 38 horse-power engine.

Rise in Copper.—The price for high conductivity copper wire has advanced ½d lb., making present basis price 0 to 20, 8d. per lb.

Electric Light on the Midland.—This railway company, after a lengthened trial, have decided to continue the illuminant. So successful is the arrangement on the main line trains that local trains will shortly participate in the benefit. Other companies please copy.

Birmingham and Electric Tramcars.—For some time past intermittent experiments have been tried in this town for the purpose of exploiting electric traction, and now we hear that cars are to be run on the Bristol Road route. As yet we have not received details.

Failure of the Schmidt Douglas Electric Company at Bradford.—The affairs of the Schmidt Douglas Electric Company, Bradford, have recently been put into liquidation, and Mr. E. Musgrave (Messrs. B. & E. Musgrave, chartered accountants, Bradford) has been appointed the official liquidator. The total liabilities of the company are estimated at £30,000, but the assets, including freehold property, plant, stock-in-trade, &c., are expected to realise about the same sum. Half the liabilities are secured. The petition for liquidation was presented by a small creditor, who could easily have been paid out could the directors have seen a prospect of redeeming their position. In view of the fact that the shareholders' money has practically been all consumed, it was not thought advisable to oppose the petition for liquidation.

Electric Traction.—A letter from Mr. John Willis on this subject must stand over till next issue.

Electric Traction in Italy.—The first electric tramway in Italy is soon to be opened between Florence and Fiesole; its total length is 7,300 metres, of which 4,000 metres consist of gradients, some exceeding 7 per cent. The line is to run on the common road from the Piazza S. Marco in Florence to the Piazza del Duomo at Fiesole, taking about 40 minutes. This concession has been granted by the Municipalities of Florence and Fiesole to the owners of the existing steam tramway from Florence to S. Domenico under Fiesole, the Societá Italiana per il Tramvia del Chianti e dei Colli Fiorentini, recently started by Messrs. Emanuelle, Fenzi & Co., Bankers of Florence. The Sprague system with overhead conductors is to be adopted on this line, so that in a few months time the most ancient of etruscan towns, full of archæological as well as picturesque attractions, will be reached through the most modern and convenient mode of locomotion. We congratulate the go-ahead people of America in being able to do for Italy what we cannot yet do for ourselves in our own land.

Significant Figures.—According to the *Scientific American* there are now in use in the United States more than 5,650 central electric stations for light and power. There are 210,000 arc lights and 2,600,000 incandescent lamps. There were 59 electrical railways in operation in March last, and 86 roads in process of construction. The increase of capital in electrical investments during 1888 was nearly $70,000,000. These are very significant figures, and they point unmistakably to the course of future inventions and discoveries.

Electricity in Vienna.—The Vienna Municipality have allowed the concession for lighting a section of the town, which was given to Messrs. Ganz & Co., to be transferred to the International Electricität Company, with the result that the shares of the latter have considerably advanced on the Stock Exchange.

Lecture on Storage Batteries.—An interesting paper on the use of storage batteries in large systems of electric lighting was read by Herr Einbeck, of Hagen, at the meeting of the Society of German Engineers at Karlsruhe the other day. This paper was written to show, from the results of actual practice, that a system of central stations can be more efficiently and more economically carried out with the aid of accumulators than without them, the saving being from 15 to 20 per cent. Herr Einbeck stated that accumulators can now be built so that a life of 10 years may be guaranteed by an annual payment of 4 per cent. of the cost of construction.

Not as it should be.—Madrid appears to be placed in a most unfortunate position. Electric light is wanted, and the French Gas Company, which supplies the place, endeavours to keep it out. We hear that two electric companies, one English and the other German, were about to take action when the gas company offered £8,000 to the German Company on condition that they left the field. We trust the English Company will not be bought over.

The Management of Primary Batteries.—In an article which we published last week on the subject of primary battery management, the name of Dr. Liepmann was, in error, bracketted with that of Mr. E. L. Mayer, to whom alone the paper and experiments were due.

The First in the Field.—The *Gas and Water Review* says:—"We are surprised that the Woking Gas Company never turned their attention to the erection of gas works under the powers conferred upon them by their Acts of Parliament. There is now little doubt that Woking will shortly be lighted entirely by electricity. We have always been at a loss to understand why a place that has grown so quickly and become a favourite residential district, being only some 30 miles from London, should so long be left without any system of lighting."

Electric Cables in New York.—The work of laying electric wires underground is still being prosecuted vigorously. Large lead covered cables are drawn into the conduits with perfect ease. The Fire Commissioners this week awarded a contract amounting to £8,000 to the Standard Underground Cable Company for Waring cables, to be placed in the subways.

Copper Steam Pipes.—Mr. W. Stepney Rawson writes as follows as we are going to press:—"Will you kindly allow me to correct a clerical error in my letter of last week, and to remove a wrong impression which might be conveyed by the same paragraph in which the slip occurred? The 'elastic limit' of Elmore copper was given as 20 tons, or 4,480 lbs. per square inch. This should, of course, be 44,800 lbs. per square inch. The next paragraph might give the impression that this figure, which is from a tensional test, is compared directly with the 360 lbs. per square inch, which was the hydraulic test applied to the tube which gave way at Deptford. This, of course, was not the intention, and I should have added, in order to make my meaning clear, a paragraph to the effect that Mr. Parker's experiments made with Elmore tubes, solid drawn, and brazed tubes of similar dimensions gave bursting strains of 3,450, 2,200, and 2,200 lbs. respectively, showing an advantage of 56 per cent. in favour of the Elmore metal. The whole of Mr. Parker's report is so fully confirmatory of the opinion formed by me of the value of the process that I cordially recommend it to those of your readers who are interested in the subject."

Results of the Strike.—The labourers employed by the Telegraph Construction and Maintenance Company at Greenwich went out on strike yesterday. A delegate from the men waited on the manager in the morning and asked him to let them have a reply to their petition on Friday evening; but as he intimated that he should not give the matter a second consideration, the whole of the labourers came out, including the foremen. The men ask for a working day of nine hours, with a minimum for labourers' wages of 4s. a day, and that working during meal hours should be abolished.

The Telephone in the French Navy.—Some interesting experiments are about to be carried out at Cherbourg with the view of testing the possibility of establishing telephonic communication between vessels forming part of the same fleet at sea. It is stated that a preliminary trial which took place recently demonstrated the fact that a torpedo boat can be kept in communication with the command afloat and receive direct orders as to where to steer and how to act in general operation. The result of further experiments will doubtless be watched with considerable interest in English naval circles.

An Electric Pump.—The *Engineer* states that an electric pump, intended especially for use in hotels, residences, office buildings, &c., has been brought out. The plant consists of a small electric motor and a rotary pump; power is taken from an incandescent electric light wire circuit, not from a battery, and the pump is driven by a worm gear. At the tank or reservoir is placed a ball float with electric connections; when water is low the pump is in operation, but when the tank is full the float makes an electric contact which stops the pump. The No. 1 size, operated by a motor of ¼-horse power, will pump 150 gallons per hour, with 25 feet suction, to a height of 50 feet. The motor and pump are very small; they are mounted on a stand and require no attention except filling the oil cups, which are of large size, every few months. It is automatic, noiseless, clean, and safe; always ready for work; cheap and economical in maintenance. The cost of operating depends upon the local charge for electricity.

A Huge Casting.—The dynamo shaft for the London Electric Supply Corporation was successfully cast at Messrs. Beardmore & Co.'s Parkhead Forge, Glasgow, on Friday last. When finished the shaft will weigh about 32 tons.

Proposed New Zealand Cable.—The Committee of the San Francisco Chamber of Commerce has, according to a Reuter's telegram, reported in favour of the laying of a cable to New Zealand *viâ* Honolulu and Tutuila, at a cost of 10,000,000 dollars.

NEW COMPANY REGISTERED.

Allchin, Linnell & Company, Limited.—Capital £50,000 in £10 shares. Objects: To take over and continue the engineering business of Frank Allchin, Linnell & Co., of Northampton. To carry on the business of an electric light and power company in all branches, and the business of electricians, suppliers of electricity for light, heat, motive power or otherwise, and as manufacturers of, and dealers in, all electrical apparatus. Signatories (with 1 share each): *F. W. Allchin, *W. A. Smith, *G. A. Spokes, Thos. Young, Hy. Allchin, Maximilian Wilson, *G. Linnell, all of Northampton. The signatories denoted by an asterisk are the first directors, qualification 50 shares; the company in general meeting will determine remuneration. Messrs. F. W. Allchin and W. A. Smith are appointed managers for three years at salaries to be determined by the board, but £300 per annum each is to be the minimum. Registered 27th inst. by R. Jordan, of Chancery Lane, agent for Pugh and Phillips, Northampton, solicitors.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Anglo-American Brush Electric Light Corporation, Limited.—On the 26th inst. the special resolutions authorising the re-construction of this company were duly filed in accordance with the Companies Acts, 1862 to 1880.

Electrical Works Construction and Maintenance Company, Limited.—The registered office of this company is now situate at 15, St. Helen's Place, Bishopsgate. The company was registered March 2nd, 1888, with a capital of £2,000 in £1 shares. The only return at present filed is the statutory return made up to June 28th, 1888, which gives seven shares as the total number subscribed for.

Telephone Company of Austria, Limited.—The annual return of this company, made up to the 14th inst., was filed on the 23rd inst. The nominal capital is £200,000, divided into 20,000 ordinary and 20,000 preference shares of £5 each. 11,703 ordinary and 52,228 preference are taken up. Upon 150 ordinary and 4,948 preference £5 per share has been called up, and upon 280 preference £4 per share has been called. 11,553 ordinary shares are considered fully paid. The calls paid amount to £26,610 and unpaid to £280.

Electric Construction Corporation, Limited.—The registered office of this company, formerly at Winchester House, is now situate at Worcester House, Walbrook.

Chili Telephone Company, Limited.—The registered office of this company is situate at 53, New Broad Street, E.C.

TRAFFIC RECEIPTS

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended 23rd August, 1889, amounted to £4,465.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending 16th August, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,303.

ELECTRIC RAILWAYS.*

By G. W. MANSFIELD.

The application of electricity to street railways has been so rapid that we are liable to lose sight of many valuable points in our herculean efforts to supply the demand. Those who are engaged in it know that they let many opportunities slip by. They cannot help it. The more generally, however, the points are known, the quicker will be the reward to some directly, and to them indirectly.

The application of electricity during the past decade has been astonishing. In the face of an industry a half century old, and of enormous wealth and power, it has won the leading position. In every direction that honest effort has been made it has succeeded. Commercial barriers have been broken down and physical obstacles swept aside. When once the feasibility was demonstrated, the end could not be predicted.

For the transportation of the people in the streets of our towns and cities the demonstration has been witnessed, the application made, and a wonderful luxuriant growth started. There is no industry so far reaching in character, so vital to a community's interests, and yet one so little known as the street railroad business. Neither the scientific world, the commercial world, nor the people themselves have realised its vast importance. Eliminate the horse car from every city or town in the union, and forecast the results.

In 1828 the now great Baltimore and Ohio Railroad started, and horses were used to draw the cars. This might be called the first horse car line in the United States. In 1830 there were 12,866,020 persons in the United States, and not a mile of street railroad nor scarcely of steam road. As a rule, the New York and Harlem Railroad, incorporated in 1831, is spoken of as the first street railroad in the country. The first car was run in November, 1832, from Prince Street to Harlem Bridge. In 1837 it temporarily succumbed to steam cars, but resumed in 1845.

The census of 1850 gives our country a population of 23,191,876, and published history but one street railroad. The child had been born, however, and in 10 years the street railroad was in almost every city of any magnitude in the country. To what has this child grown? In 1880 our population was 50,155,783. Estimating on an increase of 33⅓ per cent. in 1890, or six months hence, the population will be 66,874,354. For the transportation of this number of people in the streets of our cities and towns the most accurate figures it is possible to obtain show the engagement of about 425 companies, employing 28,000 cars, 125,000 horses, and operating some 3,500 miles of track. The capital invested is variously estimated from $175,000,000 to $200,000,000. The number of passengers carried is so enormous that it is impossible to obtain figures of any great degree of accuracy. As a result of most careful compilations and estimations, it is reasonably sure that at least 1,500,000 passengers are transported.

Still more striking is the importance of the street railroad business when compared with the magnitude and extent of the steam railroads of the United States. The figures of 1887 show a tabulation of 147,998·60 miles of railroad and 20,582 passenger cars, and passengers carried but 428,225,513. With nearly an equal number of cars and 42 times more road, one-quarter as many passengers were carried. Behold the yet more amazing figures: The horse cars of the city of New York carry 199,491,735 passengers, almost half as many as are carried by all the steam roads in the United States. If to this number are added those carried by the elevated roads, we have the total of 371,021,524, or almost as many passengers are carried in New York City alone as are annually carried by all the steam roads in the whole United States. The street railroads of the State of Massachusetts carry over 44,000,000 more people than all the steam roads in that State. One road alone, the West End of Boston, carries nearly 10,000,000 more than all the steam roads combined.

To show somewhat in detail where this tremendous traffic is, I have prepared Table I. Most of the figures showing passengers carried were obtained from reliable sources, and the balances were estimated from an average obtained from those I was sure in regard to. If you figure for each car 6 horse-power of electric energy, it will give you a rough idea of the size of an electric central station needed to operate all the cars. In New York City dynamo capacity of 13,800 H.P. would be demanded, in Boston 9,504 H.P., and so on. This is destined to come as surely as the days succeed each other. In Boston it has come, and a station of approximately 8,000 H.P. is already in the hands of the engineers. If the Conservatism of Boston permits it, how can the result be but inevitable for the other great cities of the Union? This enlightened age will have these facilities for transportation, and as soon as it is possible and wise. The universal cry to-day in almost every large city the length and breadth of the land is for cleaner, surer, and more rapid transit.

Unfortunately the tendency of the times is to concentrate in or around large cities. This means congestion with all its deplorable results. The solution lies to a very large extent in the street railways. These must be the cities' arteries and veins extending from the heart in all directions to the extremities. Improve, then, the street railways. Almost every method of applying energy to street cars has been applied, and they all have finally, except electricity, "bitten the dust" in the great battle for life.

TABLE I.—Cities of 100,000 Population and Over.

Name.	Companies.		Miles single track.	Total trackage.	No. of cars.	No. of horses.	Locomotives.	Total passengers carried.
	Elevated.	Horse.						
New York	2	...	60	89	949	...	291	171,529,789
	... ...	19	143	268	2,300	14,441	... ...	199,491,735
Brooklyn	3 miles cable included.	14	135	207	2,355	8,410	... ...	105,975,249
	3	...	24	35	247	...	91	18,632,082
Boston	... ...	1	211	231	1,534	7,684	... ...	97,039,919
Providence	... ...	1	54	54	289	1,414	... ...	15,582,732
Chicago	44 lines in one system.	7	325	325	2,400	8,279	... ...	99,348,060
Philadelphia	... ...	12	302	326	1,512	322	8 dummies.	143,433,959
St. Louis	3 cable	14	169	169	1,058	4,231	... ...	50,772,000
Baltimore	... ...	12	158	158	460	3,167	... ...	34,837,000
Cincinnati	2 cable	30 lines 7	164	164	530	2,644	4 dummies.	31,728,000
New Orleans...	... ...	7	140	140	499	2,019	18 dummies. 7 loco.	24,228,000
San Francisco	2 steam ... ... 8 cable	10	163	164	707	1,724	3 loco. 39 dummies.	130,860,000
Buffalo	... ...	2	39	56	198	1,276	... ...	13,108,203
Washington	... ...	5	63	63	336	1,684	... ...	21,892,000
Newark	... ...	3	53	52	219	1,264	... ...	15,168,000
Louisville	... ...	2	112	112	378	Mules 2,270	... ...	24,970,000
Cleveland	... ...	7	123	123	523	Horses 2,521	... ...	30,252,000
Pittsburgh	6 cable, 1 electric ...	13	113	113	347	1,924	3 dummies.	39,088,000
Jersey City	... ...	2	35	35	132	825	... ...	10,725,000
Detroit	3 electric	4	65	65	263	1,682	... ...	32,184,000
Milwaukee	... ...	3	68	68	208	1,188	2 locomotives.	16,744,000
Albany	... ...	3	19	30	103	424	... ...	4,278,927
Indianapolis	Consolidated ...	1	40	40	99	648	... ...	9,720,000
Kansas City	6 cable	7	124	124	469	613	38 dummies and motors.	33,969,000
St. Paul	1 cable	1	74	74	154	816	... ...	23,608,000
Omaha	2 cable, 3 electric ...	1	61	61	167	580	24 motors.	20,540,000
Minneapolis	Consolidated ...	1	66	66	160	1,104	... ...	14,352,000
Totals	... ...	189	3,103	3,414	18,645	77,884	... ...	1,434,057,595

Five elevated roads, 27 cable, 147 horse, 7 electric, 3 steam and horse combined—189, total, 18,645 cars, 394 locomotives, 134 dummies and motors; 77,884 horses, 2,270 mules—80,154. About 24,000 horses are annually disabled.

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* Read before the National Electric Light Association, Niagara Falls, 1889.

The Baldwin Locomotive Works have for years been engaged in the manufacture of steam dummies for street railways. Unquestionably through them the highest order of talent and skill has been lavished upon the solving of the vexed problem as to how to use steam for the haulage of street cars. Motors weighing from 13,000 to 27,000 pounds when in working order and ready to run have been built. In most cases two engines have been employed with cylinders and strokes ranging from 8 inches by 10 inches to 12 inches by 16 inches. The power of these engines can be judged from their pulling capacity, which varies from 320 to 684 tons on a level, and from 16 to 43 tons on a 4 per cent. grade. Ordinarily they were built to seat from 18 to 20 people. The wheel base was generally 6 feet and the wheels 31 inches in diameter. Naturally they were built to run at speeds from 10 to 15 miles per hour, and to be provided with all possible safeguards and conveniences. Powerful brakes were used, coke was burned to avoid smoke, mufflers provided for the exhaust and safety valves, and every other possible contrivance adopted to eliminate all objectionable troubles. Their economy in working has not been very freely published. From reliable and authentic sources we learn that the lowest fuel consumption is 6¼ pounds of coke per mile run. The average is from 15 to 12 pounds when ordinary grades are ascended. The total cost of operating per mile has been in some instances reported to be but 3¼ cents, but in other cases it was found to be over 20 cents per car mile. It is needless to say that in spite of all the skill, time and money spent upon them, they have not proven, except in a few isolated cases, either satisfactory or economical.

Electricity, the youngest of them all in application, shows already the sturdy, vigorous growth that inevitably will result in its complete supremacy.

TABLE II.

ELECTRIC STREET RAILROADS.

	1885.	1886.	1887.	1888.	Jan. 1—July 1, 1889.			Total.
					Operating.	Building.	Total.	
Number of electric railways	3	5	7	33	19	42	61	109
Number of miles of road ..	7·5	28	29	130·5	113	267	380	575
Number of cars	13	39	81	265	174	364	538	936

The figures of Table II. certainly show that the facts warrant the prediction. They were most carefully prepared, and include every road of any record. It does not show it all either. That remarkable contract which the West End Street Railway Company, of Boston, the largest street railway company in the world, signed recently with the Thomson-Houston Electric Company is not included under the heading "roads building in 1889." I think that this contract in responsibility and importance is one of the greatest that has ever been signed in the history of electricity. In electric railroading it is the greatest and probably will be for many years to come.

The West End Street Railway Company, of Boston, owns 217 miles of track and 1,584 cars, all of which are to be equipped so as to be operated with electricity. Add these to the list, and how does our list stand? If it be within the bounds of the supply men, at least 75 miles will be built this summer, and 100 or more cars equipped. Will not this give the electric railroad industry a standing warranting the attention of the whole railroad world? As an interesting comparison regarding the new industry, if I may call it such, note the following figures :—

	1870.	1880.	1890.
Total H.P., both water and steam, engaged in the whole manufacturing industry of the U.S.	2,346,142	5,410,837	Estimated. 5,255,582
Total H.P. engaged in the electric lighting and power industry	0	1,000	500,000
Total H.P. engaged in electric railway industry	0	0	30,000

In meeting this demand of the age for better transit there are many considerations that claim our most careful attention. The conditions to be met are widely different from all other electrical applications. Essentially we have first, a steam engine; second, a dynamo; third a conductor, and fourth, a motor mounted upon a vehicle and subjected to mechanical and physical conditions more extreme and severe than ever heretofore has been imposed upon any piece of electrical machinery. In the battle for success the engine has to stand the bulk of the fighting. Anything wrong with it affects directly the electric system, and in many cases it also has to stand the blows if anything is wrong with the electrical system. Dr. Bell has pointedly shown in his valuable paper many well-known facts, and clinched them by figures taken on one particular road. They can be taken, with certain allowances, as fairly representing the conditions imposed upon the steam engine by an electric road.

The extreme liability of short circuits on the road from falling wires, careless drivers turning the current on too suddenly when starting, and a variety of accidents that may happen on the very best roads render of the first importance that the engine have its main moving parts at least 20 per cent. heavier than ordinarily. Under the extreme fluctuations of load, keys, nuts and bolts will work loose. An engineer in a large station recently told me that he practically took to pieces and put together nearly every month a 100 H.P. engine running an 80 H.P. dynamo, whereas prior to the time that it had been connected to a railway dynamo it had given practically no trouble, although worked well to its capacity.

Hanscom, of cable railroading fame, writes: "We do not consider it good engineering to design an engine to suit the general average of all lines in the country." He argues special engines for every road. Mr. C. B. Holmes, president of the Chicago Cable Company, writes: "I would recommend that the strength of parts and weight of fly wheel be at least one-third greater than the usual run of engine power." Our business is analogous, and I think we should heed their counsel.

A compound engine rated at 109 H.P., running an 80 H.P. dynamo under test recently, gave the following :—

Friction card with dynamo, but no current, 11·65 H.P.
Aggregate horse-power of cards, 1,247·74 H.P.
Average horse-power of cards, 56·67 H.P.
Maximum card, 120·79 H.P.
Minimum card, 15·56 H.P.

The cards were taken at 10 minute intervals for four hours. There were at the time three electric cars on the line, each towing another. As the day was a pleasant Sunday every car was crowded. During the same time current and potential readings were taken on the line at the station. The average gave 30 H.P., or an average efficiency of 54·6 per cent. for the total time. Every moment deducted that no current was flowing would raise the efficiency. At times the efficiency was far higher than this. The road conditions were severe, the grades ran as high as 10 per cent., and had numerous others of 5 and 7 per cent. The extreme current fluctuations were noted in one minute's variation from 45 ampères to 140. The potential was very constant. On another small road the extremes varied from the friction load to nearly 85 H.P. on an 100 H.P. engine. These extremes would happen even during the time a three-impression card was being taken. Under such conditions the question of coal economy is a troublesome one. On large roads unquestionably a far better showing would be possible.

Laying aside the question of coal economy, which is cheap in comparison to food for horses, the best engine is the one that handles the average work with the least repairs. On some small roads the ratio of engine friction to average daily load may be large. The great majority of roads, however, will have a sufficient number of cars to so reduce the ratio of extremes to the average load that the engine can work at its most economical point of cut-off the major part of the time, and raise the average load to such a point above the friction load that the per cent. lost will be comparatively small.

Almost the first question asked by the manager of an electric light company when an application has been made to him for power is: "How much electric power must I allow per car?" No man can give a definite answer to this question that will meet all conditions.

If the following facts are known a fair judgment can be made, although I am much afraid that the accuracy of the judgment would not be that of a William Tell :—

1. Number of cars simultaneously operated.
2. Speed and nature of service.
3. Maximum grade, and number of grades.
4. Scheduled location of cars in reference to grades.
5. Motor cars to be used to tow other cars or not.
6. Any peculiarities in regard to the distribution of cars.
7. Condition of track.
8. Location of track in reference to power house.

A moment's thought over any one of these points, I think, will convince you of its importance. On a portion of the Cambridge division of the West End Street Railway Company's road of Boston, the Thomson-Houston Company's motors commenced running February 16th, 1889. Up to July 1st, 165,781 miles and 25,505 round trips had been made with a loss of but 325 miles, or ·19 of one per cent., and 49 round trips, or the same per cent. of loss. During this time nearly 1,500,000 passengers were carried. This, in view of the fact that during the entire time one, and part of the time two, tow cars were drawn, is remarkable. It must also be known that the route extends over one of Boston's most crowded business thoroughfares, and is the main street connecting Cambridge and Boston.

On a portion of the route there is an open bridge about 1,800 feet long, on which is located one draw, which is opened from 20 to 30 times a day. Over this bridge 1,810 cars per day pass, or on the average of one every three-quarters of a minute, and at some portions of the day they run at half-minute intervals. The teaming on this street is also very heavy, necessitating constant stopping. You will see from these figures what the loss of current or a motor burn-out causing delay would mean. The record, however, has been magnificent. As the dynamos are run by the Cambridge Electric Light Company, and are so arranged that the same engines furnish power and lights for their own purposes, as yet only approximate data as to the fuel consumption, &c., has been possible. A few electrical tests have been made, as well as it were possible. Ammeter and voltmeter readings were taken at the station every 15 minutes, four readings per minute, or at 15 second intervals. This was kept up from 6.30 a.m. to 12.30 a.m. next morning for five days. In all, 1,480 readings were taken. The average of these readings gave for 12·6 cars in continuous service, 11·6 ampères, 500 volts, or 74·8 H.P. Per car this is 8·8 ampères and 5·9 electrical horse-power. The average number of passengers carried was about 58 per round trip. We now have 32 cars in operation, and observations, in so far as they have been taken, show a marked decrease in horse-power per car. At Richmond, Va., some rough tests gave the electrical horse-power required per car at the station as from 4 to 5. On the road at Layfayette, Ill., the figures of Dr. Bell show the remarkable low figure of 2·5 electrical horse-power. There are a number of circumstances on this road that would tend to make this figure so low. The cars are smaller than those ordinarily used, and I should judge that there were other circumstances entering into the calculation that would tend to reduce it. However, it well shows, possibly, one extreme in railroading.

The other extreme might be cited in the case of the Lynn road, Highland division. Here only one car is in operation. In the course of its route it ascends a hill graded at the rate of 8·7 per cent. for 300 feet, and immediately passes down on the other side. In this case the engine was indicated. Five cards were taken when the car was ascending the grade, the average of which was 52·2 H.P. If we allowed a dynamo efficiency of 90 per cent. this would indicate an electrical horse-power of 47 H.P. This is unquestionably a very extreme and exceptional case. I might add, incidentally, that the car pays handsomely.

At Plymouth, Mass., a road having many heavy grades, the maximum being over 10 per cent., and operating but three electric cars, each with tow cars, the electrical horse-power at the station per car was approximately 7·72 H.P. On the cars the extremes vary obviously according to speed, grades, load, &c. It frequently reaches from four to five times the average value during the total time. In Lynn the variation is enormous. In Cambridge the current frequently rises to from 65 to 70 ampères, or about 42 H.P. Especially is this the case on starting. You can see from these figures the impossibility of giving only the most approximate figures in this direction unless every detail as to operation and conditions are known, I feel, however, that on roads having no grades over 5 per cent., and operating under 10 motor cars with tow cars, 15 H.P. per car would be a safe figure for dynamo capatity. On large roads this figure could be reduced to 12 and possibly 10 H.P. per car, while on small 3 or 5 car roads with heavy grades 18 or 20 H.P. might not be any too much. At Cambridge tests show that, of the total time consumed by a car in a round trip, it was taking power only 61·8 per cent. of the time, and that 6·7 per cent. of the total time the car was stopped. At Washington, where the streets were freer and not so thickly populated, the above figure for time when power was used rose to 66 per cent. Neither of these roads are what you might call large. It seems, however, that from 30 to 40 per cent. of power in excess of the absolute requirements can be planned for. I do not think, however, that this can be implicitly relied upon as in other power business, since there are many factors in the general operations of a railroad system that might at any moment tax the central station to its utmost. In regard to total electrical and total commercial efficiencies, it is impossible for me or any one else to give accurate figures. There are so many fluctuating factors entering into such a determination, that, whereas a test made to-day would give me certain figures, a test made to-morrow, or a week later, would give me entirely different figures. The time factor must enter largely into such a test.

From estimations based upon many figures, I feel certain that a total electrical efficiency of at least 70 per cent. can be obtained, and a total commercial efficiency measured from the indicated horse-power of the engine to the car wheel horse-power (W.H.P.) of from 45 to 50 per cent. If the road bed, rolling stock, and all the electrical apparatus is maintained as it should be, I see no reason why this figure cannot be exceeded.

Unquestionably, to the railroad man, one of the most vital points is the cost of repairs. We all know that in so far as power is concerned, a horse-power can be produced and delivered 10 hours per day the year round, with a profit at about $75 per year. The cost of maintaining a horse for only about four hours' work per day on a horse car is not far from $190.

There is one point which is of vital interest to the managers of electric light companies, and this is how they shall charge the railway companies for the power which they desire. I have already shown you that it is an exceedingly difficult thing to estimate upon the requisite power, as the conditions are so fluctuating and so variable. After, however, the question of the amount of power has been settled, the next point to determine is whether they shall charge the railway company by the hour, by the day, or by the car mile. We have a large number of roads already hiring power of local companies; all of the methods just mentioned are in use. Upon small roads, where the schedule of the railway company is such that they have only a few cars running continuously, meeting emergencies by extras, and where the grades are heavy, a satisfactory basis has been to charge so much per day per car, the price ranging all the way from $3 to $5, $6 and even $7. When the roads are of moderate size, or are subject to many variations and sudden demands on the part of the public for better facilities, or when the line runs to some resort, and the main bulk of business lay in picnics, &c., charges on the hour basis is sometimes preferred. This price varies from 15 to 30 cents per hour. On larger systems, where the schedule is definite and fixed, the mileage basis is the preferable by far. The prices on this basis range from 2 to 6 cents. You can readily see that if the cars ran at infrequent intervals, and if the morning and evening traffic was especially heavy and required a larger number of cars, while during the major part of the day only a few cars were out, the mileage basis would be quite unsatisfactory, since on the whole you would have to make steam possible for the maximum railroad output, and maintain it throughout the day. All of these estimates, however, can only be determined by knowing the local conditions and circumstances.

In the East, where coal ranges from $4 to $5 per ton, naturally the prices could not compete with the railroads of the natural gas and coal regions, where fuel can be obtained for almost nothing, as in some cases for 10 cents. per ton.

I would like now to enter a wedge here in favour of the very best of construction. Your own experience has probably dictated that there is no economy if the original construction be put in with either inferior or faulty material or apparatus. It is more important in railroading than possibly in lighting that the overhead construction, the track circuit, the wiring of the cars, and all other details be as perfect as it is possible for the best skill and brains to make them. If the light companies would require proper and reasonable guarantees in this direction, whenever they do supply power, it would not only be a surety in regard to their own protection, but also would be a strong inducement for the very best of construction work. The railroad man should see that it is for his interests, since there is no trouble that will consume profits more rapidly than breakdowns. There is no excuse now for electrical breakdowns. When such do happen, it is either carelessness or cheap construction.

Railroading is an exact business. The cars must be ready and go precisely on time. Delays in railroading are ruinous. All such can be avoided by perfect, honest work. I call upon electric light men to strongly urge this most vital of all considerations upon the railroad world. It is an experience we have gained at a tremendous cost. Is it not to our interests to see that others becoming associated with us do not suffer? Should not all electricians bend all their energies toward making this new and richly-promising field a magnificent success? Have you not millions to gain and nothing to lose? Are you ready for it? Are you going to do it?

There are some 1,600 central electric light stations already located throughout the country, and some 425 railroad companies that sooner or later will have to have electric power. Is there any reason why you should not do it? I know of many a station that has to stint and save to tide over the year's dull seasons. You have no day circuits; are held by the sun to one schedule, and by the moon to another. The municipal authorities jump at you from behind one post, and your commercial customers from behind the next. Stygian darkness is ever your salvation, and all conditions have to be met and illuminated by your beautiful light. You cannot afford to lose anything. Here is an opportunity for still one more chance at profit. If necessary, enlarge the scope of your charters. It will pay you. Your securities will be worth more, and can be more easily and satisfactorily placed. Railroads have an older and better standing in the financial world and on the money market than electric light companies. Can you afford to let the opportunity go by? From careful research, my own judgment would be that in many cases it would be the company's salvation. I believe the time is rapidly coming when great electric stations, from 5,000 to 20,000 H.P., are to be established. There are plants of from 5,000 to 10,000 H.P. already built for manufacturing purposes. I have been told that the Calumet and Hecla plant has in the neighbourhood of 12,000 H.P. The New York Steam Heating Company have about 10,000 H.P. of boiler capacity in their stations at Greenwich, Conn.

There are many mills equipped with power of from 1,000 to 5,000 H.P. Even our ocean steamships are plants of from 8,000 to 12,000 H.P. Why cannot electric plants of such power be built? Why are they not? Is there not business enough in lighting, power and railroading? Almost every station I go into the country over is adding to its capacity. "New occasions teach new duties, time makes ancient good uncouth." The horse is uncouth. Electricity is our life.

THE BOARD OF TRADE RULES FOR OVERHEAD WIRES.

The following regulations have just been issued by the Board of Trade, and although we referred to them briefly last week, we now reproduce them in full for future reference. Some comments upon a portion of this compilation may be found in our other columns.

In these regulations the words, terms, and expressions to which by the Electric Lighting Acts, 1882 and 1888, meanings are assigned, shall have the same respective meanings, provided that in these regulations—

"Energy" means electrical energy, and for the purposes of the Electric Lighting Act, 1888, and these regulations, electrical energy shall be deemed to be an agency within the meaning of the word electricity, as defined in the Electric Lighting Act, 1882.

"Conductor" means an electic wire or line used for the supply of energy.

"Aerial conductor" means a conductor which is placed above ground and in the open air.

"Low pressure conductor" means a conductor in which the difference of electric potential either between that conductor and earth or between that conductor or any part thereof and any other conductor on the same poles or supports does not exceed 300 volts, if the supply be on the continuous current system, or the equivalent of 150 volts if on the alternating current system. A difference of potential on the alternating current system shall be deemed to be the equivalent of a difference of potential on the continuous current system, when it produces an equal heating effect if applied to the ends of a thin-stretched wire or carbon filament.

"High-pressure conductor" means conductor in which the difference of electric potential as above described is greater than that of a low-pressure conductor.

Regulations.

1. An aerial conductor in any street shall not in any part thereof be at a less height from the ground than 20 feet, or where it crosses a street 30 feet, or within 6 feet ot any building or erection other than a support for the conductor, except when brought into a building for the purpose of supply.

2. Every aerial conductor shall be attached to supports at intervals not exceeding 200 feet where the direction of the conductor is straight, or 150 feet where this direction is curved, or where the conductor makes a horizontal angle at the point of support.

3. Every support of aerial conductors shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the conductors, or unequal lengths of span, and the conductors and suspending wires (if any) must be securely attached to insulators fixed to the supports. The factor of safety for the suspended wires shall be at least 6 and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50 pounds per square foot. No addition need be made for a possible accumulation of snow.

4. Every support, if of metal, shall be efficiently connected to earth, and if of wood or other non-conducting material, shall be protected from lightning by a lightning conductor fastened to the support along its entire length, and projecting above the support to a height of at least 6 inches, such lightning conductor being efficiently connected to earth.

A support shall be efficiently connected to earth when it is connected to metallic mains for water supply outside of buildings, or, where these are not available, to a mass of metal having a total surface of at least 4 square feet, buried to a depth of at least 3 feet in moist earth, provided that in either case the connecting conductor must possess a mechanical strength, and offer a passage to electrical discharges, equal to that of a strand of seven No. 16 galvanised iron wires.

5. Every aerial conductor shall be protected by efficient lightning protectors of pattern approved by the Board of Trade.

6. Where any conductor crosses a street the angle between such conductor and the direction of the street at the place of such crossing shall not be less than 60°, and the spans shall be as short as possible.

7. Where an aerial conductor is erected so as to cross any other aerial conductor or any suspended wire used for purposes other than the supply of energy, precautions shall be taken by the owners of such crossing conductor against the possibility of that conductor coming into contact with the other conductor or wire, or of such other conductor or wire coming into contact with such crossing conductor by breakage or otherwise.

8. The maximum working current in any aerial conductor shall not be sufficient to raise the temperature of the conductor in any part to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30° of Fahrenheit's thermometer, and efficient automatic means shall be provided which will render it impossible for this maximum working current to be by any accident exceeded to the extent of 25 per centum, even for short intervals of time; and special care shall be taken that the cross-sectional area and conductivity at joints is sufficient to avoid local heating, and that the joints are protected against corrosion.

9. Every high-pressure aerial conductor must be continuously insulated with a durable and efficient material, to be approved by the Board of Trade, to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation must not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. This insulation must be further efficiently protected on the outside against injury or removal by abrasion. If this protection be wholly or partly metallic it must be efficiently connected to earth, so, however, as not to cause undue disturbance to other electric lines or works by electrostatic induction or otherwise.

10. The material used for insulating any high-pressure aerial conductor must be such as will not be liable to injurious change of physical structure or condition when exposed to any temperature between the limits of 10° F. and 150° F., or to contact with the ordinary atmosphere of towns or manufacturing districts.

11. The insulation resistance of any circuit using high pressure aerial conductors, including all devices for producing, consuming, or measuring energy, connected to such circuit, shall be such that should any part of the circuit be put to earth, the leakage current shall not exceed $\frac{1}{15}$th of an ampère in the case of continuous currents, or $\frac{1}{10}$th of an ampère in the case of alternating currents. Every such circuit containing high-pressure conductors shall be fitted with an indicating device which shall continuously indicate if the insulation resistance of either conductor fall below the conditions required by this regulation.

12. Every aerial high-pressure conductor shall be efficiently suspended by means of non-metallic ligaments to suspending wires, so that the weight of the conductor does not produce in it any sensible stress in the direction of its length, and the insulated conductors and suspending wires, where attached to supports, shall be in contact only with material of highly insulating quality, and shall be so attached and guarded that in case they break away it shall not be possible for them to fall away clear of the support.

13. In the case of aerial conductors carrying alternating currents, the two conductors constituting the line and return for any circuit shall be run parallel with each other, and at a distance apart not exceeding 18 inches.

14. The owner of every aerial conductor shall be responsible for the efficiency of every support to which such conductor is attached, and every support shall be efficiently marked with such mark indicating the ownership of the conductor as the Board of Trade shall approve.

15. Every aerial conductor, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with such conductor, shall be duly and efficiently supervised and maintained by or on behalf of the owners as regards both electrical and mechanical conditions.

16. An aerial conductor shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the owners of such conductors intend within a reasonable time again to take it into use.

17. Every aerial conductor shall be placed and used with due regard to electric lines and works from time to time used or intended to be used for the purpose of telegraphic communication or the currents in such electric lines and works, and every reasonable means shall be employed in the placing and use of aerial conductors to prevent injurious affection, whether by induction or otherwise, to any such electric lines or works or the currents therein.

18. (*a*) A notice describing every aerial conductor erected or used for the supply of energy shall forthwith, upon receipt of these regulations, be served upon the Postmaster-General, together with a plan showing the mode and position in which such conductor is erected.

(*b*) The Postmaster-General, upon consideration of such notice and plan, may require such alteration in the position or mode of erection, or mode of use of such conductor, or compliance with such other condition as he may think fit, having regard to the protection of the electric lines or works of the Postmaster-General, and any failure on the part of the body or person owning or using, or entitled to use, the said conductor to comply with such requirements shall be deemed to be a non-compliance with these regulations.

(*c*) Any notice required to be served upon the Postmaster-General under these regulations may be served by being addressed to him and left at, or transmitted through the post to, the General Post Office, London; and any notice required to be served on the body or person owning or using, or entitled to use, any aerial conductor may be served by being addressed to such body or person and left at, or transmitted through the post to, their or his office or last known place of address.

ELECTRIC TRACTION BY STORAGE BATTERIES.*

By WM. BRACKEN.

I HAVE been invited to address you on the subject of electric traction by storage batteries.

It has been customary for speakers on storage batteries to begin their discourse by apologising for their subject. That day has gone by. The storage battery has no longer any apologies to make.

My purpose at first was to give a detailed account of the progress of storage battery traction by going back to 1881, when the first storage battery car was run, and following up the history of improvements from that time to the present. But I have found it impossible to get full and reliable data as to the work accomplished in Paris, in England, or in this country. I wrote to almost all the companies and individuals who have been engaged, or are now engaged, in storage battery traction to send me full accounts of their experiments and work; but I regret to say that only one responded to my request, and that was Mr. A. H. Bauer, who gave me a very interesting account of his experiments with his storage battery car in Baltimore in 1885-86. The published accounts of the operation and experiments of storage battery cars in Europe are so obviously inaccurate as to be unworthy of reproduction. There is one exception, however, to this, and that is the account given by the jury of commissioners at the Antwerp Exhibition of 1885 on the work of the storage battery car exhibited there; but as you are all more or less familiar with that report, I will make no further reference to it. I am, therefore, compelled to confine my remarks to my own observation of storage battery traction. I will not weary you with threadbare information. I once heard a judge tell a loquacious lawyer that he must assume the court knew *some* law. I will assume that you have a pretty general acquaintance with the storage battery in lighting and in traction but there may be some features, chiefly commercial, that have not come under your observation. My observations cover a period of over three years, during which time the company with which I am associated has directed its talents and energy to the development of storage battery traction. You all, no doubt, appreciate the difficulty of the task—not alone difficulties inherent in the system itself, but difficulties arising from the scepticism and lack of sympathy, I regret to say, of a very large majority of the electric community. We all know how much scepticism on the party of street railway men has had to be overcome in electric traction of every kind. It has taken a great deal of hard work—of missionary work—on the part of electrical engineers and inventors to bring about present results. But this is not to be wondered at, for there is nothing harder to accomplish than to supersede an old and well-established system. The horse car had plodded along and gathered strength and influence just as it had gathered fares. That influence was wide spread, and almost self-pervading, for there is hardly a town on this great continent that has not its horse car line. The horse car system had been spreading for about fifty years, and when it came to be in full and undisputed possession of the field, can it be wondered that those men who had the hardihood to attempt to supersede it should be regarded with more or less suspicion—should be looked upon as pretenders—especially when you consider that the method which they propose to employ was electricity?—that dark and mysterious science, as many people, even now, regard it.

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* Read before the National Electric Light Association, Niagara Falls, 1889.

Now, the first experiments made with electric cars were calculated to increase this suspicion and to throw disfavour on electric traction; for it is a characteristic of inventors to be so far carried away by their enthusiasm as to commit great indiscretions in carrying on experiments in public which really should be conducted in private. It was on this account that the early experiments of Daft, in 1883, and of other well-known electrical engineers in succeeding years, while they created wonder, did not beget confidence. I may say, without any invidiousness, that two years ago there was not a single electric car run in this country that proved anything more than possibilities.

There were probably two dozen cars being run at that time by the overhead wire system, but so unsatisfactorily that people who went to see them came away shaking their heads with distrust. Now all this distrust has disappeared, and electric traction has grown so fast that to-day there are no less than one hundred street car lines in this country that are either running their cars by electricity, or are in the course of introducing the system. Electric traction has beyond all doubt come to stay; as the French say, it has arrived. But the large cities are threatened with the cable. The storage battery proposes to challenge its supremacy.

There is a very general popular misconception of the nature of the storage battery. I suppose that at least 90 per cent. of the public have an idea that storage batteries are nothing but buckets, full of electricity. We read in the newspapers, from time to time, of storage battery cars carrying "tin tanks" filled with electricity. There can be no greater misconception of the nature of the storage battery. The clearest idea I can give you of the energy contained in a storage battery is to compare it with a lump of coal. The source of energy in a battery is identical with that contained in coal. It is merely energy locked up in a number of substances, principally the metals, which, when set free in a certain manner, manifests itself in a certain phenomenon we call an electric current. The metal almost universally used in the storage battery is lead in its various forms. In this lead is contained latent energy, the same as in coal, and if we compare the amount of work accomplished by the energy from either source in foot pounds, we will find it to be exactly equal in both cases. Now the general principles involved in a storage battery are very simple. When we charge a battery from a dynamo or other external source of electricity, we are manufacturing lead, and when we discharge a battery through an electric motor or series of lamps we are simply burning lead. But there is this difference between the action of coal and lead, that whereas coal apparently disappears when burnt the lead does not, but is converted into sulphate of lead to be converted back to metallic lead again by a reversal of the current, so that the storage battery is alternately burning and reducing lead to and from one of its salts. This is why the storage battery lasts and does not disappear in the extraction of the energy, as coal apparently does. In fact, the storage battery is an ideal illustration of the conservation o force and the indestructibility of matter.

When the storage battery first became known in a practical and commercial form by the experiments of Planté in 1859, scientists foresaw for it a great future, and when corporations were formed later on to exploit and introduce the storage battery, the people of Europe, influenced by what might have been considered the extravagant praises of Sir William Thomson and other well know scientists, put an enormous amount of capital into storage battery enterprises. Almost all of those enterprises, however, proved to be commercial failures; first, because the exploiters were ahead of their time; and, secondly, because the public were led to expect more than the storage battery in its then crude form would do.

There probably have been few things more difficult to accomplish than to bring the storage battery to its present stage of commercial value. Notwithstanding all that had been written about its nature and characteeistics, its treatment, both in its manufacture and use, has, until very recently, been purely empirical. That stage, fortunately, has been passed; so that, with intelligent care, the storage battery to-day is not only a valuable adjunct in lighting, but is becoming a very prominent factor in traction.

The advantages of storage battery traction, assuming that it is practical and economical, are too obvious for me to occupy your time in recounting.

The obstacles in the way of the success of the system are largely, if not wholly, overcome. The chief of these was the *handling* of the batteries. That was the most difficult and the last obstacle to be overcome. Two improvements removed these difficulties. First, the *flexible conductor*, by which it is possible to couple up or remove cells with great rapidity; and secondly, the battery rack, occupying a floor space of 24 × 7 feet on each side of the car, wherein can be stored a sufficient number of batteries to run from 10 to 20 cars, according to its location. This rack represents stall room for 150 horses, or say 6,000 square feet. I regard this rack as the greatest improvement hitherto made in storage battery traction. By its aid we remove the batteries from a car, and replace them by another set in from two to three minutes. Indeed, our cars on Madison Avenue, New York, have to leave the station on six minutes headway. In the afternoon trips there is but six minutes' interval between their arrival and departure; and they all receive their batteries from the same rack. When the car enters this rack, its panels are dropped down on either side and thus form bridges over which the batteries are withdrawn from, and replaced in, the car. While this change is being made, a competent person inspects the regulators of the car. The motors, gearing, and connections are only inspected once a day, and that at the end of the day's work. You will thus perceive that the great bug-bear of how to store the batteries is no longer an element in storage battery traction.

From my observation of the recent work on Fourth and Madison Avenues, now that a number of cars are running, and under very unfavourable conditions as to station room and the like, I am led to believe that the storage battery car is as free, if not freer, from accident, as cars that are run by the overhead system. The motors are, I think, subjected to less trying conditions, owing to the fact that the E.M.F. is always uniform. The batteries never give out on the trip. It is impossible for them to do so, as they leave the station with 35 electrical horse-power hours stored in them, and do not consume quite 12 in the round trip of 12 miles. The battery in service has never been short-circuited. When the current required exceeds 150 ampères, the battery is automatically cut out. When rigid connectors were used, breaking was frequent, and the flexible connector has, until recently, given some trouble from time to time by jumping out of position while the car is in service; but with recent improvements, disconnection of the batteries while the car is in service is now rendered almost impossible. For several months past the regulators have caused absolutely no trouble. In any event there are two on the car, so that if one should fail the car may be operated from the other end. You will thus perceive that the likelihood of accidents or breakdown is reduced to a minimum. The first standard car has run in three months over 6,000 miles, and carried over 80,000 passengers, never having missed but one-half a trip in that time, and that arose from a bent axle. It has never had an accident or stoppage of any kind while in service. Do not be sceptical at the assertion when I tell you that not a dollar has been spent on that car in the way of repairs or alterations.

At this stage you will naturally ask, How about the life of the battery? I answer that, from our observation, there is nothing to fear on that score. A life of six months from the positive plates is sufficient; it is found that they will last very much longer than that. The chief reasons why the short-livedness of a storage battery has been so much talked about and feared, is that it has, until recently, cost so much to manufacture the battery. Now, the material for your battery you have to buy, in a great measure, but once, for the reason that the discarded battery can be made over new. The raw material in two sets of battery, capable of running a car 120 miles a day, costs, exclusive of the containing jars, about $300. Have you machinery and devices requisite for manufacturing this raw material cheaply into a battery? If you have, you need have nothing to fear on the score of economy. It will cost $4,000 to purchase enough horses to run a 16 foot car 120 miles a day; it will cost about $1,500 to purchase enough battery to do that work. The batteries can be maintained for about one-half what it costs to maintain the horses; and by maintaining, I mean replacements as well as feed. This I know for a fact. Can we then have any further doubt as to the relative economy of storage battery traction?

The cars on the Madison and Fourth Avenue line take one electrical horse-power hour per mile. The road has some long gradients. The grade at Centre Street is over 4½ per cent., and 600 feet in length.

The cost of motive power for a car-day of 75 miles we estimate at $3.40, as against $7.50 for horses. Five dollars for 75 miles ought to cover the cost in winter. By motive power we mean the cost of energy at 2 cents per horse-power hour, and $700 per annum for maintenance of batteries and motors. To those who may think that 2 cents per horse-power hour is a low estimate, it may be said that power has been offered in New York, to be delivered at our station at the price above named. In towns outside of New York offers have been made to supply current at lower figures. The more level the road, the cheaper obviously will be the cost of motive power. This is more particularly true of the storage battery, which in excessively steep and long grades becomes heated. The chemical energy, instead of exhibiting itself in the form of electrical energy, exhibits itself in the form of heat, with consequent injury to the battery. Cars will ascend very steep grades; but it is not deemed economical to attempt grades of more than 6 per cent., and they must be short at that rate. But there are few roads offering more and steeper grades than the road we are now operating on in New York. Each car has two sets of battery. A set is easily charged in about two-thirds of the time the other is in service. No time is lost in charging, as the battery is automatically put in circuit with the dynamo as soon as it is withdrawn from the car. Now that there is a complete group of cars in service in New York, it is hoped to follow those by another group of 10. More will be known about storage battery traction at our next annual meeting.

AMERICAN NOTES.

By DAS TELEPHON.

Commissioner of Patents Mitchell has rendered a decision involving an important question of office practice. The Commissioner's decision, briefly stated, is that when a patent is inadvertently granted for an invention which is claimed by another applicant whose application is pending at the same time, without priority being decided on between the two parties by proper interference proceedings, that in an interference being subsequently declared between such patentee and such applicant the rights of the parties will be determined upon the same ground as if both were still applicants and neither patents had been granted, and that an affidavit of the applicants that his invention antedated the other is not necessary to secure an interference.

The Solicitor of the Treasury Department has been called upon to decide an interesting question in regard to the introduction into the United States of electricity generated in a foreign country. It seems that a company has established an electric plant at Niagara Falls on the Canadian side and propose to extend their wires to Buffalo for illumination and other purposes. Before laying their wires in the United States they have asked the opinion of the Solicitor of the Treasury Department whether the electrical current thus transmitted into the territory of the United States would be subject to duty as a foreign manufacture. Under existing laws it seems that it would be impossible to levy and collect any duty upon an invisible, imponderable, and impossible something.

The company which proposes to furnish electricity as above has been organised under the Laws of Virginia, under the name of the Niagara Hydraulic Electric Company. It is stated that the company has secured from the Ontario Government in Canada the right to use the water at the Horseshoe Falls on the Canadian side, and that they intend to tunnel through the rocks to the end of the river, so as to avoid danger from ice in winter. This company proposes to furnish light, power, and heat to various points within a radius of 40 miles, and to build electric railways to Buffalo, Lockports, Clifton, Hamilton, and other places; work will be begun in September under the control of a syndicate of American and Canadian capitalists.

That Canada is to have a direct cable to Great Britain seems to be a settled fact. Application has been made to the Government to guarantee bonds of the "Canadian Cable Company" to the extent of $500,000, the total capital required is $1,000,000. Mr. Dobell, it is said, has already secured $350,000 of this in England by subscriptions, and intends to return to London with the expectation of raising this sum to $500,000.

There is reason to believe that the Canadian Government will grant the aid asked, as Sir John Macdonald and Sir Hector Langevin have expressed themselves favourable to the plan.

Mr. F. N. Gisborne, superintendent of the Canadian Government Telegraphs and Signal Service, says:

"The Belle Isle route will be 1,900 nautical miles in length, and will be 150 miles northward of any transatlantic cable now laid, in addition to which the depth of the ocean will be considerably less, and the cable will be free from all risks during the repairs of other cables.

"The company have only to provide and maintain the main cable or cables of not exceeding 1,900 miles in length, the connection eastward being with the Imperial Government Post Office telegraph service, and westward with the Canada Government telegraph service at Greeley Island in the Straits of Belle Isle. Hence the company will be at no outlay of capital for terminal cables.

"It is practicable, as one of the principal cable manufacturing companies in London has tendered to provide, lay, and guarantee a cable of the most approved type for $1,500,000.

"The company's line will cost only one-fifth of the Anglo-American's cost, one-fourth of the Direct United States, Compagnie Française, and Western Union, and about one-third of the cost of the Commercial Company's cable, and, at the same time, its annual maintenance charges will be moderate."

The first Session of the Tenth Convention of the "American Electric Light Association" met at Niagara Falls last week. The President, in his address, stated that the primary object of the association was to advance the interests of local companies, and secondly to aid in the general development of electrical business, and to promote the interests of manufacturers of electrical apparatus and supplies.

Statistics collected by the secretary show that the number of arc lamps in the United States alone has increased from 219,924 to 237,017, that of incandescent lamps from 2,507,490 to 2,704,768. The number of street railroads now operated by electricity is 109, equipped with 936 motor cars, with 775 miles of track. The capital invested in these industries is now $510,000,000.

A company is about being organised in Baltimore to place in operation a system of telegraphing to and from moving trains, invented by Baylus Cade. Under this system a wire is laid along the railroad near the track and the communication is made with the moving train by a drag descending from the car and attached to a Morse intrument in the car.

This system differs materially from that of Edison, in that the latter strings the wire over the cars and telegraphs by induction. Some trials recently made at Raleigh, North Carolina, apparently demonstrated the success of the system.

Mr. Harold P. Brown, the electrical "Jack Ketch" of the State of New York, exhibited to the committee on the legal electrical death penalty, a diagram of the machinery and apparatus devised in prison for executing criminals. It exhibited the criminal with a cap drawn over his features, the subject being seated in something like a steamer chair to which he is strapped by a belt around his waist. His arms were pinioned and his feet rested on a raised block. Near by was a dynamo, and from the machine wires ran to his feet and his head. The criminal could move his head, but the wire being flexible followed the motion of his head. A kind of helmet rested on his head, and the flexible wire was connected to a binding post on the top of the helmet. This post was attached to a round upper plate one-sixteenth of an inch thick and two inches in diameter, and a wet sponge was placed between this upper plate and the head of the criminal.

It appeared from Mr. Brown's description, that the death of a criminal by his device will be a highly scientific affair.

There are several criminals now awaiting execution in the jail in New York city; the manner of their taking off, however, is yet undecided.

Baltimore, *August 16th*.

NEW PATENTS—1889.

12731. "A plate for secondary batteries." W. P. Kookogey. Dated August 13. (*Complete.*)

12736. "An improved form of insulator for carrying electric wires." C. Brown. Dated August 13.

12752. "Improvements in machines for filling secondary battery plates." H. G. Morris and P. G. Salom. Dated August 13. (*Complete.*)

12760. "Improvements in electric motors for street cars." W. S. Salisbury. Dated August 13. (*Complete.*)

12722. "Improvements in means or apparatus for the generation and conversion of electric energy." A. de Castro. Dated August 13.

12773. "Improvements in the system of electric locomotion." F. Wheeler. Dated August 13. [Date applied for under Patents Act, 1883, Section 103, 14th January, 1889, being date of application in the United States.]

12795. "Improved means and appliances for feeding the carbons of arc lamps." J. Kent. Dated August 13.

12799. "Improvements in single fluid batteries." A. H. Chesnier and F. B. A. R. de la Bastie. Dated August 13.

12815. "Improvements in electro-motors." F. V. Andersen and J. O. Girdlestone. Dated August 14. (*Complete.*)

12869. "Improvement in apparatus for measuring electric energy." A. A. Day. Dated August 15.

12901. "Improved means for supporting and separating the plates of electric accumulators." R. E. B. Crompton. Dated August 15.

12908. "Improvements in registering mechanism or counters actuated by electric currents." R. Jewell. Dated August 15.

12970. "Improvements in printing telegraph instruments." J. E. Wright and J. Moore. Dated August 16.

12982. "An improved motion for electrical switches." T. Barton. Dated August 17.

12998. "Improved electric apparatus for clocks." C. Wells. Dated August 17.

13001. "Improvements in electric fire alarms." H. de Pouipiquet. Dated August 17.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888.

12832. "Improvements in conductors for armatures of dynamo-electric machines." F. V. Andersen. Dated September 5. 8d. Claim:—Conductors for armatures of dynamo-electric machines composed of a number of metallic strips or tapes soldered together at convenient points but left free for the greater part of their length, and with or without insulating substances between them and longitudinal slots and openings within them, such conductors being attached to the armature so that the individual strips of which each conductor is composed stand edgewise on the core, substantially as and for the purposes described.

12963. "An improved telephone." J. P. Zigang. Dated September 7. 8d. Consists of a very small horseshoe electro-magnet of soft iron wound with insulated wire of one-tenth to two-tenths of a millimetre in section according to the resistance of the outer circuit. The extremities of the two poles are rivetted into a bar of copper by which the electro-magnet is fixed into the interior of the instrument, the bar of copper being sufficiently heavy to prevent the molecular vibrations caused by the alternate partial magnetisation and demagnetisation from being communicated to the wooden mount of the telephone. The insulated wire coils are also coated with a thick covering of shellac varnish, and by their inertia prevent longitudinal vibrations which might interfere with the proper action of the poles upon the armature. The electro-magnet is contained in a hollow case or handle of hardwood having at one end a circular opening about 15 millimetres in diameter, and at the other end a small opening for the passage of the conducting wires from the coils. A ring or washer of wood is screwed against the larger end of the case and holds the edge of the diaphragm firmly against the latter. The diaphragm itself consists of a disc of copper about $\frac{1}{100}$th of a millimetre thick and 18 millimetres in diameter, having fixed to its centre a small rectangular piece of soft iron $\frac{15}{100}$th of a millimetre thick, and of a size large enough to cover the ends of the two poles. 1 claim.

13000a. "Improved means or devices for making electrical contacts in coupling up electric conductors." T. M. Sargeant and O. R. Swete. Dated September 8. 6d. The inventors provide a screwed stem projecting from the place to which the wires are lead, and over this screwed stem one of the wires is placed, its end encircling it, and preferably being squared and flattened at this part, and it is seated upon an elastic washer placed over the stem before the wire is placed thereover. The second wire (preferably squared and flattened) is then placed around the stem and then another elastic washer is placed over the stem, and then there is placed over this second washer a vulcanite or like washer with an annular edge, which may be formed by the cupping of the washer, and then a nut is screwed on the stem, the said nut at its inner side being preferably dished or cupped to fit the back part of the cupped washer. 4 claims.

13208. "Improvements in the use of incandescent electric lights." C. Wells. Dated September 12. 6d. The inventor attaches or fixes incandescent electric lamps to the ends of radial arms, or on a disc, to which a rapid revolving motion is given. Each lamp, instead of forming a speck of light, produces a circle of light, the diameter of which is proportional to the distance of the lamp from the centre. 1 claim.

13221. "Improvements in mechanical telephones." G. F. Redfern. Dated September 12. 8d. The inventor employs a frame case or box, preferably square and resting upon two parallel base bars or string pieces extending a short distance beyond the sides of the box. The back of the box, which serves as a sounding board and, which rests, as stated, upon string pieces is, by this construction, held away or raised from any surface to which the telephone box may be placed or attached, as, for instance, a wall, the instrument being secured to the same, however, by screws or nails inserted through the projecting ends of the string pieces. At the corners of the box are placed four corner posts which are provided with slots adapted to receive and securely hold the ends of the thin sideboards of the telephone box. Four flat bars or string pieces, forming a rectangular frame, are placed upon the corner posts and sideboards and behind the inner face of the sounding board which forms the face of the box, for the purpose of strengthening the box, the various parts are bound together by bolts or screws passing through the sounding board and string pieces into the corner posts. A diaphragm (constructed preferably in two parts) of compressed fibrous material, as for example, "leatheroid" or "vulcanised fibre," is fastened to the inner side of the sounding board by the following means. A diaphragm plate is secured by screws to the sounding board and is preferably depressed or concave at its centre and adapted to be connected with a line wire by being provided with a central opening in order to receive a concave or dome-shaped reflector of parabolic or hemispherical section provided with a flanged edge placed between the diaphragm plate and sounding board. The sounding board is under tension while in use and vibrates simultaneously with the diaphragm. 8 claims.

1889.

3401. "Improvements in or connected with current regulators for dynamo-electric machines." E. A. Sperry. Dated February 26. 8d. Relates to a simple arrangement of mechanism for regulating the current of dynamo-electric machines. 31 claims.

3456. "Electric circuit couplers." S. C. C. Currie. Dated February 26. 8d. Relates to electric circuit-couplers of the class in which the circuit is automatically opened or closed simply by separating or uniting the members of the coupler; its objects are to enable this result effectually and quickly to be attained—in the dark as well as in the light—without liability to connect circuits of wrong polarity; and at the same time not only to insure effective electrical contact, but also securely to protect the circuits and their connections from injury. These ends are attained by securing the circuit-connections or terminals in their respective protecting cases, frames, handles or stocks in such manner that they can only be connected in proper relation. 6 claims.

6064. "Improvements in the construction of cores for electro-magnets," armatures for dynamo-electric machines or electric motors, and for similar appliances." H. H. Lake. (Communicated from abroad by Prof. Elihu Thomson, of America..) Dated April 9. 8d. Relates more particularly to the form of magnet with an endless laminated core, that is, one which consists of a number of plates of iron piled one upon another to form a laminated structure to which the electric coil or coils are applied, and the object of the invention is to secure ease of construction, simplicity, efficiency, and facility of repair, and at the same time to obtain a perfect closure of the magnetic circuit which passe through the centre of the coils. 6 claims.

6527. "Improvements relating to electro-motors." H. H. Lake. (Communicated from abroad by Nikola Tesla, of New York.) Dated April 16. 8d. Consists in a simple method or plan of operating synchronising motors, and one which requires practically no other apparatus than the motor itself. In other words, by a certain change in the circuit connections of the motor, it is converted at will from a double circuit motor, or such as is now known as a Tesla motor, and which will start under the action of an alternating current into a synchronising motor, or one which will be run by the generator only when it has reached a certain speed of rotation synchronous with that of the generator. 4 claims.

6547. "Automatic circuit controllers for electric circuits." S. C. C. Currie. Dated April 16. 8d. Relates to that class of apparatus in which the current is subject to changes of direction, or sudden reversals of polarity, incident to changes of electromotive force in different members of the apparatus, relatively to each other; as, for instance, in the case of dynamo-electric machines coupled in multiple arc, or a dynamo and accumulator in the same circuit. The objects of the invention are so to organise the apparatus as to secure its prompt and effective action at all times, combined with simplicity of construction. These ends are attained, by combining with the main circuit of a dynamo-electric machine, an accumulator or equivalent device, a coil of comparatively thick wire influencing a magnet, and an armature controlling the main circuit, but energised by a separate coil of comparatively fine wire, in circuit with the dynamo. 9 claims.

CORRESPONDENCE.

Electric Traction in the States.

After reading your leading article in the Review of July 19th, commenting on the interesting paper read by Mr. Daft before the American Institute of Electrical Engineers, I think that when alluding to the ton weight, as mentioned in the article referred to, it should be distinctly stated that the ton adopted by the United States differs from that recognised by Great Britain, the former containing only 2,000 lbs., a difference of 240 lbs. from the latter.

I mention this so that the uninitated may see how the conclusions are arrived at.

Gus. C. Lundberg.

252, W. Fifteenth Street, New York City,
August 15*th*, 1889.

Electric Traction with Storage Batteries.

Nine long years have elapsed since I first took up the advocacy in favour of secondary batteries for electric traction, and you must be well aware that I have missed few opportunities to bring this question to the front. In the earlier days I discussed possibilities only, but as experience advanced I brought facts and figures relating to everyday practice. In your somewhat pessimistic article of last week on "The Brussels Electric Tramway," you challenge me to explain the reasons for the apparent want of commercial success with the cars which have been running at Brussels for several years past, and which are still running. I cannot think why you should ask me to explain matters over which I have absolutely no control, unless it is that you desire a general survey of the subject as it appears on the face of published reports. I have watched with the greatest interest the proceedings at Brussels, and I admire the energy and perseverance of M. Julien, who has so long worked against adverse circumstances.

According to the report of the director of the Brussels Tramway Company, M. Julien has demonstrated that traction by means of accumulators is more costly than by means of horses. The results with three electric cars have been compared with an extensive and economically worked system of horse cars. One might as well compare the cost of running a 30 H.P. steam engine against another of 3,000 H.P. In the one case the H.P. per annum would probably cost £20, and in the other less than half that amount. M. Michelet stated that the cost of traction in each case was precisely the same, but that in the electric car estimate no account was taken of the depreciation of plant at the charging station. When working on a reasonably large scale this item could be covered by something like ¼d. per car kilometre. This can easily be calculated by anyone having experience with steam engines, boilers, and dynamos; it should be a well known quantity. The doubtful quantities on the Brussels cars were the depreciation of batteries, car motors, and the mechanical transmission between the motors and the car axles. These have been carefully ascertained, and it was shown in the report that the battery renewal costs 9 centimes per car kilometre, and that the repairs to motors and gearing came to 5·74 centimes, which in English equivalents make 1·44d. and ·94d. per car mile respectively. These items are undoubtedly high, and with all that the entire expenses of electric traction were little higher than those of horse traction. Yet you say that "there is much to concern one in this report from Brussels, for it must be remembered that all data relating to electric traction by means of secondary batteries is more or less hypothetical." I am prepared to prove that the renewal of accumulators does not cost more than one penny per car mile, or thirty per cent. less than the above amount. Again, the depreciation of motors and gearing should not reach half the figure given, because even this half would allow 25 per cent. per annum on the gross value of the apparatus, and I feel convinced that many firms would guarantee their work on this basis.

Anyone not prejudiced in favour of some rival system must perceive in the report from Brussels hopeful signs of prosperous times coming for storage battery traction, and instead of being discouraged, as you evidently felt when preparing the leader in last week's issue, we ought to find in this very report renewed evidences of success. The track at Brussels is beset with all sorts of difficulties, therefore the results already obtained thereon must be regarded in their true light. At New York, Philadelphia, and other American cities, tramway traction with storage batteries is making steady and certain progress, and we only require the necessary opportunities in this country to fully demonstrate its ultimate commercial value. At present we have to contend with prejudices which cannot be wiped out entirely and solely by writing or lecturing on the subject, therefore I close this letter without further comment.

A. Reckenzaun.

August 27th, 1889.

[We are very pleased that our correspondent takes such a sanguine view of the ultimate outcome of running tramcars by means of accumulators, for we have always shared the belief that our large town lines can be operated only on this system, for what is admissible in American cities at the present day is never likely to obtain here.—EDS. ELEC. REV.]

The Curve of a Westinghouse Machine.

You say in a note that Prof. Ayrton, or Prof. Forbes, or I, said that the Westinghouse machine gave a sawtooth curve, and not a curve of sines. I believe I alone am responsible for mentioning saw teeth in connection with the Westinghouse machine. What I did say in your Journal in the autumn of 1887 was: "As already mentioned, different types of machine give different no load curves. A Westinghouse machine gives a sawtooth curve with the points somewhat rounded over. A machine patented by the writer last year gives a sawtooth with the points still sharper. In machines with a large air space the rounding over is generally greater, so that the curve somewhat resembles the curv sines." I then go on to discuss full load curves.

I saw the curves I believe you refer to in the *trical Engineer*, but have not the paper by me. I th however, they are full load, or, at any rate, not no curves.

The quotation is from some articles on elect measurement, so I did not go fully into the reasons what I then said about alternating machinery, as would have been out of place. As, however, it see to be thought in some quarters that I wrote in haphazard way without knowing what I was abou may perhaps be allowed to say a little more now. machine like the Westinghouse had the pole ends oc pying half the periphery of the armature, and if coils also occupied half the periphery, and were so th that there was no air space, the curve would obvio be a saw tooth. If there is an air space, the field und the poles is no longer quite uniform, as there is a fri under each edge. This rounds the top over. T Westinghouse machine has very little armature w and small air space, so that its no load curve approa a saw tooth more nearly than that of most machines.

At full load the pole pieces are cross-magnetised, mentioned in my article. This makes the field strong under the trailing corner of the pole piece, and weak under the leading corner; this alters the curve, and makes it unsymmetrical, so that after the maximum the E.M.F. does not fall as quickly as it rose before it. This seems to be shown in the curve now given. As the maximum is now, after the coil has gone half way under the pole the armature current tends to demag- netise the field. This does not, however, alter the form of the curve, which is what I was discussing; it merely lowers the E.M.F.

The argument that a Westinghouse curve is not sinusoid because it is a saw tooth with its poin rounded, is, I admit, not very strong, because a sinuso itself closely resembles it. Even the load curve of th Westinghouse machine now under discussion fits su a saw tooth curve very fairly well. In fact, the ca resembles that of the various empirical formulæ for merly in use for direct current machines. Any of these old formulæ would give a characteristic som where about right if suitable values were give to the coefficients. Similarly, given an actual alte nating curve, a rounded saw tooth, a parabola, hyperbola ellipse, sinusoid, or free-hand curve strained—that is, having its co-ordinates altered to scale—could be drawn to fit it pretty closely. In making comparisons between actual curves and sinusoids, the sinusoids should not be chosen to lie as nearly over the actual curve as the eye can make it, but should be taken to represent an equal virtual current, as it would be taken from a dynamometer reading. The ordinates of the actual curve should be squared, and the area of the resulting curve taken. A curve of sines should then be taken, to give equal area when its ordinates are squared. This may not fit as well by eye. The question of apparent nearness of coincidence of the curves is again unimportant; what is really of consequence is the error that would be made in assuming the curve of sines and making the ordinary calculations. On resistances the error would obviously be *nil*, on motors it might be very considerable.

May I express a hope that we will have more experiments on the actual curves of machines? Their valu cannot be overrated, especially if the electrical and mechanical measurements of the dynamos are also given.

Jas. Swinburne.

Universal Telephones.

For the benefit of your correspondent, whose lette dated Stockport, August 15th, and signed "Phone, appears in your issue of the 23rd inst., I beg to infor you that I am the maker of the instruments referred

George L. Ander

August 26th, 1889.

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